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WE GUARANTEE, that of this issue 11,000 copies were printed; that of those 11,000 copies, 9,869 copies were mailed or delivered by messenger to regular paid subscribers; 950 copies were distributed among members and guests of the American Railway Engineering Association and at the Coliseum; 131 copies were mailed to advertisers; and 50 copies were set aside for office use.

CONTENTS:

Edwin F. Wendt, who was elected president of the American Railway Engineering Association yesterday, is assistant engineer of the Pittsburgh & Lake Erie, with office at Pittsburgh. Mr. Wendt was educated in the public schools of New Brighton, Beaver County, Pa., and was graduated from Geneva College, Beaver Falls, Pa., in 1888, with highest honors in the classical course. He entered railway service in 1888 as axeman and chainman in the engineering corps of the Pittsburgh & Lake Erie and served continuously with that road in the different positions of axeman, chainman, rodman, levelman and transitman up to October 1, 1898, since which time he has been assistant engineer in charge of maintenance of way, construction and contract work. Since he has been connected with the engineering department of the Pittsburgh & Lake Erie, this road has been extended and reconstructed; second, third and fourth tracks have been built, large terminal and classification yards and the extensive new locomotive and car shops at McKees Rocks have been constructed and the new Pittsburgh station and general office building has been built. Mr. Wendt was elected a member of the Engineers' Society of Western Pennsylvania in 1890; a member of the American Society of Civil Engineers in 1903, and a charter member of the American Railway Engineering Association in 1900. He has been especially active in the work of the latter association, being chairman of the committee on "Records and Accounts" during 1903-4-5; a member of the committee on "Signals and Interlocking," 1906-13, inclusive; a member of the Board of Direction during 1908-9-10; chairman of the committee on "Publications" during 1912-13; second vice-president in 1911 and first vice-president in 1912. He has also been a member of the Board of Trustees of Geneva College, Beaver Falls, Pa., since 1907, and is a member of the University Club of Ptitsburgh. By training, experience, talents and personality Mr. Wendt is fitted for the presidency of the greatest railway engineering association in the world—an association that has numbered among its presiding officers some of the leading engineers of the railways of North America.

In his discourse at the dinner last night on the effect of music on the railways George A. Post suggested to the railway men that they push from the center of the stage those who sing of what is the matter with the railways and themselves trill a few notes about what is not the matter with the railways—about what they have and the creditable things they do. The public seems to need to learn that the music of railway operation and development is more important and necessary than the music of railway regulation—and this is not said to minimize the need and importance of regulation. About the only feasible way of informing the public about the good features of railway management and operation in this country, one of the things that are needed to make them better, is, as Mr. Post indicates, for railway men to sing about them. After a while railway men may be able to get other people to take up the tune; but they will have to teach it to them first.

In the discussion of the first conclusion of the committee on Wooden Bridges and Trestles, that it be recommended as good practice to use guard timbers on all open floor bridges, the legal aspect of the matter should be borne in mind. There is a difference of opinion as to the necessity for guard rails on bridges. Many engineers believe that their installation does not insure the safety of a derailed car. One member went so far as to say that he believed that in many cases a black mark painted upon the tie would be equally effective. This view is not shared by most of the membership of the Association; and many roads place guard rails on all open floor bridges. But if the Association goes on record as recommending guard rails on all open floor bridges as good practice, it places the railroad which does not install them in an embarrassing position in a lawsuit. The recommendations of this important Association have great weight in court; and they should not be made without due regard to this fact.

After working under difficulties in securing information for the past two years, the committee on Economics of Railway Location made a report yesterday which, while incomplete in many ways, presented many points to be considered in the locating of main lines. No other report made at this year's convention has brought out so much discussion; and this fairly measures the interest aroused by it. Many of the statemens of facts and some of the conclusions drawn are open to argument; and probably the committee presented them in the form it did to draw out discussion. It has been unusually difficult to get the data essential to a thorough study of the subject, the principal reason being that very little information regarding the cost of operation of trains

under varied conditions of grade, curvature, temperature, etc., has been kept in such form as to make practicable valuable comparisons. The facts brought out by the committee should serve as the basis for further useful investigation that will call forth data confirmatory of some and contrary to others of the conclusions drawn. In his written discussion W. J. Wilgus points out a number of places in which the conclusions of the committee may be questioned. But the conclusions of Mr. Wilgus are open to some of the same objections as those of the committee. There are not sufficient data in existence for accurate determination of the importance of the various factors to be dealt with; and until this ceases to be true it will continue to be difficult to draw sound conclusions.

It is probably too much to expect that any simple formula regarding railway location can be developed which will be applicable to all conditions. But there are many elements of uncertainty which can be eliminated. The principal business of a railway, from a purely revenue standpoint, is the transportation of freight. The net earnings depend mainly on the economy with which this traffic is handled. Therefore from a business standpoint the subject of this committee is very important; and effective study of it will be productive of large results in the form of net revenue. In a study of the savings which would be made by the construction of a new line on an eastern railway a few years ago, it was found that the old line was not being operated to its best advantage, and as a result of a careful engineering investigation the method of operation was so changed that a very great reduction in the cost of operation on the old line was made. The objection sometimes raised that the association should be careful not to step over into the realm of the transportation department is not weighty, for the function of the engineering department, as of all other departments, is to move traffic. As Mr. Himes aptly expressed it, the engineering department might rather be called the "co-operation department." It is to be hoped that this committee's report and the discussion of it will serve as a means of bringing out much further information. To collect and compile the data essential for a thorough study of the subject will require the continual service of a number of men; and it would seem that the railways either individually or through the American Railway Association could well afford to assume the necessary expense for this.

PRESIDENT WORTHINGTON'S ADDRESS.

The address made by President Worthington of the Chicago & Alton at the annual dinner of the Engineering Association last night was typical of the public utterances now being made by railway executives who are progressive and public-spirited and who clearly recognize the conditions with which railway managers are confronted. Mr. Worthington was optimistic. He expressed the belief that the railway problem in this country can be solved by government regulation; and he implied that government ownership would not solve the present problem but merely substitute for it a much harder one. While he was optimistic, he based his optimism not on the belief that all the present tendencies and methods of public regulation would work out satisfactory results, but that the wisdom of the American public would change some of these tendencies and methods.

Railway managers formerly were reticent. They have become very frank. They are telling their troubles to the public as frankly as Mr. Worthington did last night, not because they especially like to tell them—they would greatly prefer not to have any of them to tell—but because, as the public now regulates and controls railway managements, the railway problem can be solved only by co-operation between the managers and the public.

Some railway men at times despair regarding the results of frank and full discussion of the railway situation. They say that spokesmen of the railways have been presenting their case to the public for years now, and that the number of people who have learned very many facts about railway conditions and that believe what the railway managers say is still small. As a matter of fact, the number of people who now have some understanding of the railway situation and a desire to see the railways intelligently and fairly regulated unquestionably is greater than it ever was before. That the number is not still greater is not surprising. The management of railways was not formerly so circumspect in many ways as it is now. Meantime, there was a growing storm of both just and unjust criticism. Railway managers neither did enough during this period to effect needed reforms nor to explain and defend the conditions that were explicable and defensible. The work of years cannot be undone by the work of months. The railways are much better managed and much better defended than they ever were before. But they will have to be thus managed and defended for a long time yet before public opinion regarding railway matters will become satisfactory.

The engineering department has not come so much in contact with public regulation as some other departments. The traffic department now has the rates that it may charge largely dictated to it. The mechanical department must comply with federal and some state laws in inspecting locomotive boilers, installing safety appliances, etc. The operating department has the number of men it must employ in train crews fixed by law in many states, as well as the hours that employes may be kept at work, etc. The engineering and maintenance of way department is quite likely at almost any time to be confronted with measures for the regulation of various details of roadway, track and structures. There are two ways to deal with proposed regulation. One is, if it is right, to do voluntarily the thing it is proposed to require to be done. The other, if the thing proposed is wrong, is to meet the advocates of the proposed legislation squarely and try by facts and logic to prove to their satisfaction and that of the public that their proposals are wrong. Fortunately, the railway engineers of this country understand these things. While, however, the engineering department has not as yet come very directly in contact with public regulation, it has felt its effects. Regulation has tended to hold down and reduce earnings, and this has tended to interfere with adequate expenditures for maintenance and new construction.

There seems to be only one way to improve regulation and its results, and that is constantly to discuss them fully and frankly. Some years ago Edwin Lawrence Godkin, long the editor of the *New York Evening Post*, and of the *Nation*, wrote a paper entitled "The Duty of Educated Men in a Democracy," in the course of which he said: "One hears every day from educated people some addition to the number of things which 'governments' ought to do, but for which any government we have at present is totally unfit. One listens to them with amazement, when looking at the material of which our government is composed, for the matter of that, of which all governments are composed, for I suppose there is no question that all legislative bodies in the world have in twenty years run down in quality. The parliamentary system is apparently failing to meet the demands of modern democratic society, and is falling into some disrepute; but it would seem as if there was at present just as little chance of a substitute of any kind as of the dethronement of universal suffrage. It will probably last indefinitely, and be as good or as bad as its constitu-

ents make it. But this probable extension of the powers and functions of government make more necessary than ever a free expression of opinion, and especially of educated opinion. We may rail at 'mere talk' as much as we please, but the probability is that the affairs of nations and of men will be more and more regulated by talk. * * * So I shall, in disregard of the great laudation of silence which filled the earth in the days of Carlyle, say that one of the functions of an educated man is to talk, and, of course, he should try to talk wisely." Mr. Worthington said in his address that the Engineering Association is "a body of professional men whose fundamental requirement in order to qualify in their calling is a most liberal technical education; gentlemen who, I might say, represent the culture and aristocracy of the railroad profession." The application of Mr. Godkin's remarks to men of the class which Mr. Worthington thus described is obvious. Do the highly-educated, broad-minded and able railway engineers of this country fully live up to their duty as "educated men in a democracy" by discussing the railway business with people outside that business as much as they might?

TO-DAY'S PROGRAMME.

XIV.	Yards and Terminals	Bulletin 154
XVIII.	Electricity	Bulletin 155
XIX.	Conservation of Natural Resources	Bulletin 154
II.	Ballast	Bulletin 154
VI.	Buildings	Bulletin 154
VIII.	Water Service	Bulletin 154
Special.	Grading of Lumber	Bulletins 144, 154
I.	Roadway	Bulletin 154
XI.	Records and Accounts	Bulletin 155
	New Business.	
	Installation of Officers.	
	Adjournment.	

A. H. RUDD RESIGNS AS CHAIRMAN OF COMMITTEES X AND I.

Committee X on Signals and Interlocking of the American Railway Engineering Association and Committee I on Signaling Practice of the Railway Signal Association had their annual dinner at the Congress Hotel Tuesday evening. A. H. Rudd resigned as chairman of both committees, and the members decided upon T. S. Stevens, signal engineer of the Atchison, Topeka & Santa Fe, as his successor to both of them, subject, of course, to the action of the directors of the two associations. C. C. Anthony, assistant signal engineer, Pennsylvania Railroad, was chosen for vice-chairman. The membership of these committees is practically identical. It is customary to appoint to membership on Committee I of the R. S. A. all members of that organization who also belong to the A. R. E. A., and are members of Committee X.

THIS FROM A RAILROAD MAN!

A well known railroad man was asked this morning what he thought of the exhibit as a whole. His reply was, "It is very artistic."

This coming from a railroad man was more than unexpected, but it is highly expressive at that. The exhibits of some previous years have been some other things than artistic, principally because it is rather difficult to get together a bunch of "stuff" made of iron and steel, concrete and brass, wire and paint, in a shape that has a right to any of the very numerous and elastic applications of the word "artistic."

The show this year, however, is artistic, and the general arrangement is much better, and the exhibits more attractive than ever before—if such a thing is possible.

PENNSYLVANIA IMPROVEMENTS AT PHILADELPHIA.

The board of directors of the Pennsylvania Railroad have authorized the electrification of the main line for suburban passenger traffic from Philadelphia to Paoli, a distance of 20 miles. Involved in the scheme is some six-track improvement work which, with the widening of the Broad Street station, will afford much needed terminal relief. The first work to be undertaken will be that previously announced in the *Railway Age Gazette*, which includes the construction of an eight-track station at North Philadelphia, and the building of additional tracks on the connecting railway, involving a new arch bridge over the Schuylkill river at Girard avenue.

BY REQUEST OF COMMITTEE ON ARRANGEMENTS.

The committee on arrangements on being notified through yesterday's Daily of the action of the convention in referring to them paragraph 34 of the "Instructions for the inspection of the Fabrication of Steel Bridges" reading, "Have important members so loaded as to be headed in the right direction upon arrival at the site of the work," delegated L. C. Fritch to advise the convention during yesterday morning's session that the committee would accept this assignment on the condition that members come to them fully loaded and with their headlights burning so that there can be no mistake as to which direction they are going.

J. T. BRANTNER GIVEN MEDAL FOR FIFTY YEARS' SERVICE.

J. T. Brantner, superintendent, Martinsburg shops, maintenance of way department, Baltimore & Ohio, Martinsburg, W. Va., has been awarded a gold medal for the completion of 50 years' continuous service on that road. Mr. Brantner entered the service January 1, 1863, so that his half century of connection with the system was completed December 31, 1912. He is the first man to be awarded a medal for such service. Mr. Brantner is attending the convention of the American Engineering Association.

BALTIMORE & OHIO DINNER.

Sixty-three officers of the Baltimore & Ohio attended the annual dinner yesterday noon of representatives of this road attending the convention. Earl Stimson, chief engineer maintenance of way, presided and gave a short talk, being followed by J. A. Spielman, engineer maintenance of way, Pittsburgh; G. W. Andrews, general inspector of maintenance, Baltimore, and J. T. Brantner, superintendent, frog and switch shops, Martinsburg, W. Va.

HOWARD & ROBERTS.

Through an error, C. P. Howard of the newly organized firm of Howard & Roberts, was referred to in Tuesday morning's Daily as having been connected with the Canadian Pacific. Mr. Howard has been with the Illinois Central for several years and many of his friends no doubt realized the error in the previous notice.

DEAN TURNEAURE HERE.

F. E. Turneaure, dean of the college of engineering, University of Wisconsin, who is in attendance at the convention, has just returned from Europe, where he has been making a study of railway conditions on the European roads.

Proceedings.

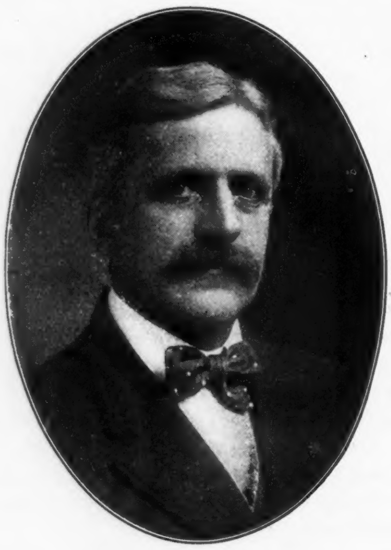
PROCEEDINGS.

The Wednesday morning session of the American Railway Engineering Association was called to order at 9:20 a. m. by President Churchill.

ECONOMICS OF RAILWAY LOCATION.

The chairman has made a study to determine the approximate general laws affecting such maintenance of way accounts as are influenced by changes in physical characteristics of locations and presents the results of this study for the consideration of the association. It is not assumed that the analysis of the accounts for the 53 railroads shown in the table gives the correct cost per mile of main track, but it is believed that for the major portion the figures are within reasonable proximity of the truth, and that the individual diagrams show with sufficient accuracy the general law of ratios of increased cost for a fixed unit of traffic to the portion of expense due to age or decay.

The conclusions presented are recommended for adoption, believing that the application of the formulas therein to the normal annual charge for each account will eliminate considerable of the guesswork of the past. The ratios of cost per mile of side track to mile of main track on any particular line can be estimated without too great an element of guesswork, and in the average case it will not be found far from the suggested value in the table. With these conclusions adopted your committee has a way opened for the further study of questions entering into economics of location.



A. K. SHURTLEFF,
Chairman Committee on Economics of Railway Location.

ANALYSIS OF MAINTENANCE OF WAY AND STRUCTURE ACCOUNTS.

The majority of the problems of economics of railway location deal only with main track questions, although an occasional problem introduces the consideration of side-tracks. It is therefore necessary to analyze and separate certain of the primary operating accounts between costs for main track and costs for sidings, particularly those accounts covering maintenance of way and structures.

Great difficulty has been found in obtaining the necessary information from the railway companies to aid in the proper analysis of the questions. Only three or four railroads out of the many asked for information have attempted to give any data to aid in the digest of this particular question. However, the question has been studied on one large system of nearly 8,000 miles of main tracks and does not vary materially from the ratios of cost per mile of main and side tracks of the other three roads. The figures cover a period of four years and are used in the following analyses, believing them to represent a fair and reasonable average of the relative costs of maintaining main and side tracks for most of the railways of the United States. The figures will not apply to roads lying entirely within a dense manufacturing or mining district where the necessary mileage of side track nearly equals or sometimes exceeds the main track mileage, and the switching mileage is so heavy as to make the tonnage over the side tracks exceedingly large. The methods of this analysis can be followed in such a case, using the ratios of costs that have been found proper for the heavy switching traffic on the industrial sidings.

The following gives only the accounts which are particularly due to both main and side track usage:

Account 1.—Superintendence of Way and Structures. One mile of side track requires practically one-third the cost of one mile of main track.

Account 2.—Ballast. One mile of ballasted side track averages only about one-fourth the cost of one mile of ballasted main track. This factor is a difficult one to reach logically and is a matter of judgment. No detailed figures have been obtainable, as usually only a minor portion of side tracks are ballasted and not all main tracks.

Account 3.—Ties. The number of renewals per mile of side track for four years averaged about 70 per cent of the number per mile of main track. The side track renewals embraced No. 2 ties as well as No. 1, and the average cost per side track tie was about 70 per cent of the cost per ties for main track, making the total charge per mile of side track practically one-half of the cost per mile of main track.

Account 4.—Rails. Main line rail was relaid by new rail, re-rolled rail or good relayer rail of heavier section, in all cases the renewal portion of the charges being only the tonnage equal to the weight of the released rail at the charge per ton for the material replacing it. Side track renewals were from relayer rail only and charged out on the above principle according to the form prescribed by the Interstate Commerce Commission. The arbitrary credit for relayer rail released and charge for same used was practically 75 per cent of the cost of new rail. Scrap released was credited at approximately market value. The average charges per mile of side track for rail renewals was about 25 per cent of the cost per mile of main track.

Account 5.—Other Track Material. Practically 37 per cent of this account was account of frogs and switches, the major portion being to frogs, hence due entirely to side tracks, although many existed in the main track. A careful analysis shows that one mile of side track costs practically the same as one mile of main track for this account due almost wholly to the costs of turnout frogs and switch points.

Account 6.—Roadway and Track. The cost per mile of side track averages about one-third the cost per mile of main track. This is due not only to the lower grade of maintenance of side track, but to the fact that many items charged into this account are principally main track items, for example, ditching, bank widening, track walkers, cutting weeds on right of way, etc.

Account 9.—Bridges, Trestles and Culverts.

Account 10.—Over and Undergrade Crossings. Occasionally a small portion of these two accounts is chargeable to side tracks, but for the majority of cases the amount is so small as to be negligible in economic calculations.

Account 18.—Roadway Tools and Supplies. One mile of side track requires about one-third the cost of one mile of main track.

In the remaining accounts of maintenance of way structures the side track mileage rarely affects the amount of the account and can be neglected in economic calculation. The main track portion of these accounts per mile of main track can be obtained by dividing the total charge to each account by the equivalent main track mileage, the latter being the total main track mileage plus the product of side track mileage by the proper per cent of cost per side track mile for the given account.

The above accounts are all materially affected by volume of traffic except Account 2, ballast, and Accounts 9 and 10, bridges, culverts, over and under grade crossings.

The train mile has been commonly used as a traffic unit in economic studies in the past, but it is illogical to use this unit as a measurement of wear and tear on the track owing to the wide limits in weights of trains that can be handled by the same locomotive in districts of different gradients. A train with gross weight of 2,000 tons will cause about double the wear and tear on the structure that would be caused by one of half the weight. The ton mile would be the best unit considering total weights on

RAILROAD	Equivalent 1,000 Ton Miles per Mile Main Track			Costs per Mile Main Track						Renewals per Mile of Main Track		
	Freight	Passenger	Total	Acct. 1 Supt.	Acct. 6 R.W. & T.	Acct. 18 R.W.Tools Etc.	Acct 4 Rails	Acct. 5 Other Track Material	Acct. 16s Building	Tons Steel	Ties No.	Ties Average Cost
Pennsylvania R. R.	8,920	4,695	12,724	$142	$918	$ 28	$129	$131	$359	11.51	248	$1.00
D. L. & W.	7,338	4,532	11,870	111	619	33	301	152	294	20.22	209	.83
Pennsylvania Co.	7,629	4,106	11,735	109	774	12	107	101	265	3.86	228	1.13
P. & L. E.	8,269	2,771	11,040	136	1,282	40	171	161	348	24.86	384	1.17
N. Y. C. & St. L.	8,898	2,120	11,018	71	665	20	119	101	121	11.29	367	78
P. & R.	7,888	3,627	11,515	100	681	26	130	117	279	12.22	287	.87
Vandalia	3,817	2,900	6,717	105	455	13	67	51	95	2.38	285	.65
L. S. & M. S.	6,060	4,412	10,472	77	824	48	90	105	260	5.78	289	1.12
N. Y. C. & H. R.	5,451	5,062	10,513	119	619	23	165	107	279	15.60	260	.85
C. R. R. of N. J.	6,263	3,996	10,259	71	714	14	128	120	457	16.24	242	.94
Northern Cen.	6,500	3,258	9,758	133	743	20	144	138	677	9.61	215	1.42
N. & W.	7,652	1,766	9,418	51	517	32	147	106	167	11.06	380	.57
P. C. C. & St. L.	5,979	3,368	9,347	100	704	9	97	85	161	3.39	205	1.20
Erie	5,766	3,269	9,045	82	569	19	105	80	167	18.02	233	.84
Lehigh Valley	6,405	2,280	8,685	76	469	17	109	70	196	7.54	153	.98
B. & O.	6,053	2,799	8,852	83	598	11	92	52	164	6.37	170	.93
P. B. & W.	3,478	5,558	9,036	141	678	26	56	93	293	5.73	310	.89
D. & H. Co.	6,151	2,311	8,462	46	377	15	77	77	134	5.00	176	.73
C. C. C. & St. L.	4,720	3,424	8,144	68	496	16	53	87	187	6.04	327	.87
C. & O.	5,688	1,770	7,458	50	504	18	69	73	123	6.11	317	.64
Wabash	4,155	2,642	6,797	34	445	8	71	56	100	3.44	397	.59
C. & A.	3,897	3,001	6,898	57	532	12	42	82	136	5.68	275	.67
Illinois Cen.	3,965	2,341	6,306	60	486	18	44	62	158	4.36	258	.64
Long Island	805	5,651	6,456	125	525	25	25	43	251	2.30	195	.92
D. M. & N.	4,749	790	5,539	46	149	28	69	66	176	5.89	204	.44
C. & E. I.	3,846	1,779	5,625	58	253	7	28	47	63	3.00	123	1.07
Mobile & Ohio	4,077	1,392	5,469	41	364	12	38	54	88	4.36	476	.40
L. & N.	3,487	1,888	5,375	64	427	18	113	67	200	7.02	324	.68
S. P.; G. H. & S. A.	2,170	3,146	5,316	82	602	31	76	96	147	6.60	283	.57
A. T. & S. F.	2,603	2,536	5,139	90	564	28	55	56	160	7.01	302	74
U. P.; O. S. L.; O.-W. R. R. & N. Co.	2,322	2,455	4,777	77	514	28	30	57	128	5.25	243	.78
N. C. & St. L.	2,739	1,931	4,670	52	607	14	42	47	115	2.74	519	.43
C. G. W.	2,526	1,898	4,424	84	342	7	17	43	78	16.59	441	..
C. B. & Q.	2,351	1,943	4,294	62	454	8	69	26	126	15.01	337	.56
C. & N.-W.	2,269	2,074	4,343	41	407	8	46	35	112	4.58	227	.52
C. R. I. & P.	2,176	2,184	4,360	62	371	11	34	35	132	2.85	245	.79
Canadian Pac.	2,298	1,879	4,177	45	580	16	68	40	164	9.11	240	.40
M. K. & T.	2,072	2,063	4,135	47	434	16	11	45	83	3.00	420	.48
Southern	2,176	2,033	4,209	55	299	9	73	47	83	5.89	374	.49
C. St. P. M. & O.	2,118	1,953	4,071	40	367	8	59	34	106	6.24	262	.50
C. M. & St. P.	2,400	1,618	4,018	28	311	15	53	34	89	7.24	197	.54
Northern Pacific	2,074	1,935	4,009	59	501	11	28	30	79	3.17	404	.45
Great Northern	1,968	1,933	3,901	64	561	11	28	41	66	3.14	320	.52
St. L. & S. F.	2,030	1,908	3,938	70	335	14	21	37	76	2.67	396	.52
Pere Marquette	2,295	1,300	3,595	33	267	6	18	33	65	4.63	192	.66
Texas & Pacific	2,051	1,439	3,490	30	364	13	32	41	135	2.64	329	.50
Mo. P.; St. L. I. M. & S.	2,050	1,492	3,542	76	384	15	61	53	77	6.64	409	.53
D. & R. G.	1,845	1,685	3,530	73	493	21	21	31	69	1.80	283	.70
Y. & M. V.	1,932	1,125	3,057	65	468	28	35	66	118	3.19	430	.58
Seaboard Air Line	1,674	1,538	3,212	38	319	13	23	46	91	4.69	381	.35
Atlantic Coast Line	1,586	1,536	3,122	39	269	11	66	41	89	9.92	324	.41
M. St. P. & S. Ste. M.	1,788	1,293	3,081	17	246	7	2	16	53	1.75	234	.27
Cen. of Georgia	1,453	1,360	2,813	63	270	11	62	42	94	6.42	362	.43
Average cost per mile of side track in per cent of main track cost				33⅓%	33⅓%	33⅓%	25%	100%				

Cost of Maintenance on Accounts Affected by Traffic.

the rails if freight traffic only passed over the track, but passenger traffic also must be considered and owing to the higher velocity of trains the damage done per ton of passenger train is greater and the labor of maintaining track for the higher velocities is increased. With velocities equal, the damage done to track will vary about directly proportional to the load per axle and one ton of locomotive will create more disturbance to track than one ton of car and contents.

The following gives some average axle loads for the heaviest types of modern locomotives and for average loading for cars. It will be many years before the average locomotive loading reaches these figures, while the average car loading will probably increase:

	Average load per axle.
Passenger service.	
Atlantic locomotive	39,100
Pacific locomotive	37,800
10-Wheel locomotive	22,000
Average passenger train car	22,000
Freight service.	
Mikado locomotive	48,500
Consolidation locomotive	44,600
Mallet Comp. locomotive	42,300
50-ton capacity gondola car, loaded one way return empty	22,500
Average 35 tons per car of freight train (above present average)	17,500

The present average of load per axle of freight and passenger locomotives in less than double the average load per axle of train.

In studying average maintenance expenses by divisions for a period of years on the large system previously mentioned it appeared that the best unit of traffic measurement of expense was what we will term the equivalent ton mile. The total equivalent ton miles would be the sum of the following:

Double the freight locomotive mileage times average weight per locomotive.

Four times the passenger locomotive mileage times average weight.

Total freight ton miles (cars and contents).

Double the passenger ton miles (cars and contents.)

This unit considers that one ton of passenger car does double the injury of one ton of freight car, and that one ton of locomotive affects the track as much as two tons of the train back of the locomotive. This unit of measurement even best fits the increase of maintenance of buildings due to increase of traffic and consequent increase in number and size of buildings. Passenger traffic demands a higher type and better grade of maintenance than freight, and even a better type of shop buildings for repair.

With the exception of Account 4, rails, there is a minimum expense for the accounts affected by the volume of traffic due to depreciation and decay. This expense must be met to keep the road in shape for operation. The increase in expense above this minimum is practically directly proportional to the equivalent ton mileage passing over the tracks. There may be a slight loss of rails by corrosion, but its effect on the general account cannot be noticed and the cost can safely be considered directly proportional to the equivalent ton mileage.

Criticism may be made of adopting a traffic unit that involves the estimating of passenger train tonnage. Nothing can be done of value if the work of the committee is to be based in the terms of statistics as kept at the present time. Net ton miles, freight and passenger train

car mileage is kept, also road engine mileage separated between freight and passenger service. Weights of locomotives are a matter of record. The estimating covers the assumption of an average weight for empty freight cars, which at present is about 18 tons, and an average weight per car and load of passenger train cars. At the present time 44 tons per passenger train car of the average train will not lead to great error, and the average passenger train of the United States has approximately 5.3 cars per train. This last figure is not necessary for use where passenger train car mileage is available.

Early in the present year the Interstate Commerce Commission published a pamphlet, "A Preliminary Abstract of Statistics of Common Carriers for the Year Ended June 30, 1911." The information in this pamphlet is more complete with reference to operating data of individual roads than has heretofore been published. The accompanying table showing the items of costs of the maintenance accounts affected by traffic is deduced from data given by the Commission, using the ratios of costs per mile of sidetrack as outlined to reduce to cost per mile of main track only. As only average weights of locomotives, excluding tender, were given, two-thirds of the weight was added to cover weight of tender and the same weight of engine was assumed for both passenger and freight service. The ton mileage was worked from net ton mileage and the mileage of the two classes of cars and road engines.

There is no attempt to place the cost of ties in dollars per mile of track as there is probably no account in which there is a wider variety of materials or unit costs than in ties. Climatic conditions affect the tie question, particularly noticed when comparing the roads of the South with those of the North. It is evident that the roads using either properly treated woods or timber of a high grade, and protecting the ties from mechanical wear by heavy tie plates with good bearing area, are receiving good returns because of the practice.

In all of the accounts it must be recognized that some of the roads were above the normal in the various accounts and other roads below. Taking the data from several years' operation of a railway, the following formula will give the average expense of maintenance due solely to age and decay for the accounts where both decay and mechanical wear enter the question and using the tabular values for the functions as deduced from these statistics for 1911 the average expense for any volume of traffic per mile of main track can be estimated:

A = Total main track mileage.
B = Total side track mileage.
C = Average annual charge to the given account.
P = Proportional charge per mile of side track as compared with charge for main track only.
X = Annual charge per mile of main track to keep in condition for proper operation covering the amount due to age or decay.
R = Proportion of X representing the additional charge per mile of main track for each million equivalent ton miles per annum.
M = Million ton miles traffic per annum per mile of main track.
E = Charge per annum per mile of main track only, for the given account.

$$E = \frac{C}{A + BP} = X + MRX = X\ (1 + MR)$$

$$\text{Then } X = \frac{C}{A + BP + MR\ \ (A + BP)}$$

The values given for P and R in the tables with conclusions are suitable to determine the average value of X for the great bulk of the railroads of the country, providing a sufficient number of years' data is used to produce a normal average. For the exceptional cases where a large portion of the total track mileage consists of busy industry spurs and sidings, suitable values for P must be ascertained.

The data given for ties is based on a study of renewals on different divisions of the same line with widely varying traffic. On track where ties were of a high grade timber or creosoted and with a large proportion of ties protected by heavy tie plates, the renewals in main track were 6.5 per cent. of the total in the track plus 0.3 per cent. for each million equivalent ton miles traffic. This figure appears to fit very closely the northern half of the United States, where the roads have taken means to properly protect the ties. In the southern portion the percentage due to decay will be greater, but by multiplying the proper percentage by the value 0.46 per million equivalent ton miles, the average renewals can be approximated for cases where proper methods are used to retard mechanical wear. Each locality can determine within reasonable limits the value of the constant renewals required due to decay for the available timbers.

Account 4, rail renewals, apparently costs about $11 per mile of main track for each million ton miles and requires about 1.1 tons of new rail for this traffic. This figure will answer under present conditions of rail renewals and checks very closely with some data gathered on the equivalent ton mileage per mile of track during the life of 80-lb. tangent rail on a busy double track division. The maximum equivalent tons over any of the rail was 147 millions. The tangent rail released was in condition for relaying or for re-rolling and considering 110 million miles the average for this rail would make practically 1.1 tons per million equivalent ton miles.

According to custom the maintenance charges are only for the weight released less the arbitrary credit for the usable released material, although heavier sections may be used for replacements. The relaying rail when used to replace still lighter sections on districts of less traffic will further reduce the maintenance charge, as the rail finally released fixes the final distribution of the total cost between maintenance and betterments. It is apparent that as the average weight of rail approaches the modern heavier section betterments will absorb a less proportion of expense of rail renewals and maintenance charges will be increased. Sufficient data is not at hand to show whether the heavier rail will withstand an equivalent increase in tonnage directly proportional to its weight. It can hardly be expected to do so as head wear determines the necessity of renewals where rail sections are sufficiently stiff for the axle loads. The cost of rail renewals will probably be found to bear a different relation to the volume of traffic in a very few years.

The other maintenance of way and structures accounts affecting main track are for all practical purposes independent of the volume of traffic. Most of them are dependent either on mileage of main track or mileage of road. Tunnels, bridges and culverts and over and under grade crossings are dependent on the topography of the country and materials of construction, and in comparing the relative economy of different locations the amount and character of the tunnels and bridges on each must be considered in estimating the difference in maintenance costs.

The tables in the conclusions give the accounts under their respective headings. Other maintenance of way and structrues accounts may be ignored, as they bear practically no relation to location.

Average values for any of these main accounts can be obtained from Interstate Commerce Commission reports for the leading roads in all sections of the country.

The foregoing covers only the foundation of the work for analyzing the effect of changes in physical characteristics on maintenance of way and structures accounts. It can be seen that distance affects nearly all of the accounts mentioned and that the volume of traffic affects only a portion of them. Curvature affects only the rail renewals and roadway and track accounts with a very slight addition to tie renewals, providing that good substantial tie plates having large bearing area are used. It must be assumed that proper details of construction are used in the initial work in estimating relative values of different lines. Future study of the committee should be to determine the effect of curvature on the accounts mentioned and then take up the study with reference to maintenance of equipment and conducting transportation expenses.

The following are the conclusions with reference to the present study:

CONCLUSIONS.

1. The problems of economic location deal only with main track in the majority of cases, side tracks entering into the question only where differences in distance are so great as to necessitate additional side tracks.

2. The annual charge per mile of main track for any account embracing both main and side track can be approximated for any operated line by the following formula:

A = Total average main track mileage.
B = Total average side track mileage.
C = Average annual charge to the account.
P = Proportional charge per mile of side track as compared with charge per mile of main track.
E = Average annual charge per mile of main track only.

$$E = \frac{C}{A + BP}$$

The average value of P is shown in the table, but for roads located almost wholly within dense mining or manufacturing districts requiring an exceedingly large proportion of busy side and spur tracks the values would be higher and should be determined.

3. The accounts covering maintenance of main track do

not all vary by the same general law, but vary most directly according to the following groups:

(a) Affected by both miles of track and volume of traffic.
(b) Affected by miles of main track.
(c) Affected by miles of road.
(d) Affected by local topographical features.

Therefore no single unit of measurement of relative maintenance expense is applicable to all accounts in comparing the relative economies of two locations. The tables show the groupings of the accounts under their proper heading.

4. One ton of passenger train does more damage to track than one ton of freight train and the locomotive creates more disturbance than an equal weight of cars and contents. Until data is available to correctly estimate the relative damage, it is recommended that the following ratios be used in estimating effect of traffic on the accounts in group (a):

One ton of passenger car and contents produces approximately the effect of two tons of freight car and contents.

One ton of locomotive produces approximately the effect of two tons of the balance of its train.

The total ton mileage reduced to terms of ton miles of freight car and contents is termed the *equivalent ton mileage.*

Most of the accounts in group (a) have a constant maintenance expense due to age and decay, plus an additional expense depending on volume of traffic. This additional expense per mile of main track varies most directly with the *equivalent ton mile.* The equivalent ton mileage can be approximated by adding together the following:

Net freight ton mileage.

Double the freight locomotive mileage times average weight in tons.

Freight train car mileage times the average weight of empty cars (at present about 18 tons).

Double the passenger train car mileage times the average weight of car and contents (at present about 44 tons).

Four times the passenger engine mileage times the average weight in tons.

5. The average annual expense per mile of main track due to age or decay for the accounts in which this item enters can be approximated for any road by the following formula:

E = Charge per annum per mile of main track only.

X = Annual charge per mile of main track due to age or decay.

R = Proportion of X covering the additional charge per annum per mile of main track for each million equivalent ton miles.

M = Million equivalent ton miles per annum per mile of main track.

Then from the above and the equation in Conclusion 2.

$$E = X + MRX = X\ (1 + MR) = \frac{C}{A + BP}$$

$$X = \frac{C}{A + BP + MR\ (A + BP)}$$

Average values for P and R are shown in the tables.

ACCOUNTS AFFECTED BY MILES OF TRACK AND VOLUME OF TRAFFIC.

No.	Account.	Avg. Values. P	Avg. Values. R	1911. Avg. Values. X	1911. Avg. Values. RX	Remarks.
1	Superintendence	0.33	0.44	$ 18	$ 8	
2	Ties (based on number used)	0.7	0.046	Varies	...	Cost, quality and climatic conditions vary widely.
2	Ties (based on cost)	0.5	0.046	Varies	...	Local conditions must determine value of X. Curvature affects charges but lightly where protected by proper plates and fastenings.
4	Rails	0.25	.....	0	...	Present average annual charge per mile of main track is $11 per million ton miles, or 1.1 tons new rails for same traffic. Curvature affects this account.
5	Other track material	1.	.....	0	...	Present average annual charge per mile of main track is $10 per million ton miles. Affected slightly by curvature.
6	Roadway and track	0.33	0.245	$200	$49	Affected by curvature.
16	Buildings	0.	2.4	10	24	Affected only where distance or increased volume of traffic makes additional buildings necessary.
1[illegible]	Tools and supplies	0.33	0.40	5	2	

ACCOUNTS AFFECTED BY MAIN TRACK MILEAGE.

No.	Account.	Remarks.
2.	Ballast	For full ballasted track this varies with the quality of ballast and cost laid down at side of track.
7.	Removal of snow and ice	Varies widely, depending on climatic conditions.
13.	Signals (block signals only)	Present average cost $125.00 per mile with average of one signal to the mile. Curvature may necessitate additional signals.
20.	Stationery and printing	

ACCOUNTS AFFECTED BY MILEAGE OF ROAD.

No.	Account.	Remarks.
11.	Grade crossings, Fences, cattle guards and signs	Mileage of main track affects this account slightly, but variation is most directly in proportion to miles of road.
12.	Snow fences and snow sheds	Varies widely, dependent on climatic conditions.
14.	Telegraph and telephone lines.	Varies slightly per mile of road, depending on number of wires.

ACCOUNTS AFFECTED SOLELY BY TOPOGRAPHICAL FEATURES.

No.	Account.	Remarks.
8.	Tunnels	The expense of these items depends on the number, size and character of the structures on each location.
9.	Bridges, trestles and culverts	
10.	Over and under grade crossings	

REVISION OF MANUAL.

The committee recommends that Conclusion 2, page 436, of the Manual, be changed to read: Numerous tests demonstrate that there is no absolute value for train resistance. For practical purposes freight train resistance can be considered constant between velocities of 7 and 35 miles per hour; that Conclusions 3 and 7 be eliminated and the matter under subhead 1 on page 618 of this report be substituted; also the table on page 615; that for conclusion 4 there be substituted conclusions 1-4 on pages 620 and 621, and that conclusions 8 and 9 be renumbered 7 and 8, respectively.

A. K. Shurtleff (C. R. I. & P.), Chairman; R. N. Begien (B. & O), Vice-chairman; F. H. Alfred (P. M.), A. C. Dennis (Cotr. Engr.), C. P. Howard (I. C.), F. W. Green (La. & Ark.), P. M. LaBach (C. R. I. & P.), Fred Lavis (Cons. Engr.), F. W. Smith (C. C. C. & St. L.), H. J. Simmons (E. P. & S. W.), Walter Loring Webb (Cons. Engr.), M. A. Zook (C. G. W)., Committee.

APPENDIX A.

RATIO OF LOCOMOTIVE EQUIVALENT TON MILEAGE TO TOTAL.

The accompanying table shows the per cent. of equivalent ton mileage that the locomotive bears to the total equivalent ton milage of its class of traffic for the roads given in the table in the body of the report. Owing to the fact that both tables were made on the average weight of locomotives of the road, passenger and freight engines considered the same, the percentage shown for freight locomotives is probably lower than it should be and the percentage for passenger service higher since the average freight locomotive weighs more than the passenger types.

PER CENT. LOCOMOTIVE EQUIVALENT TON MILEAGE BEARS TO TOTAL EQUIVALENT TON MILEAGE OF ITS CLASS OF TRAFFIC.

Road.	Frt.	Pass.	Road.	Frt.	Pass.
Pennsylvania R. R.	20	55	Sou. Pac. and G. H. & S. A.	23	49
D. L. & W.	23	49	A. T. & S. F.	28	53
Pennsylvania Co.	21	51	Union Pac., O. S. L., O.-W. R. & N.	24	51
P. & L. E.	11	57	N. C. & St. L.	29	47
N. Y. C. & St. L.	19	39	C. G. W.	24	54
P. & R.	21	57	C. B. & Q.	22	48
Vandalia	24	50	C. & N.-W.	26	51
L. S. & M. S.	20	52	C. R. I. & P.	27	52
N. Y. C. & H. R.	24	53	Can. Pac.	25	45
C. R. R. of N. J.	28	58	M. K. & T. (including Texas)	26	48
Northern Cen.	21	54	Southern	28	53
N. & W.	24	55	C. St. P. M. & O.	27	44
C. C. C. & St. L.	23	62	C. M. & St. P.	26	47
Erie	22	51	Nor. Pac.	24	53
Lehigh Valley	21	54	Great Nor.	21	48
B. & O.	26	57	St. L. & S. F.	29	53
P. B. & W.	24	52	Pere Marquette	23	53
D. & H.	28	60	Texas & Pac.	24	48
C. C. C. & St. L.	22	54	Mo. Pac., St. L. I. M. & S.	26	54
C. & O.	18	55	D. & R. G.	34	50
Wabash	22	51	Y. & M. V.	17	40
C. & A.	23	54	Seaboard Air Line	28	48
Ill. Cent.	22	49	Atlantic Coast Line	24	47
Long Island	40	41	M. St. P. & S. S. M.	23	49
D. M. & N.	15	61	Cent. of Georgia	24	41
C. & E. I.	19	63			
Mobile & Ohio	25	50			
L. & N.	27	50			

This table is given as information to show the approximate amount of damage done by the locomotive for each class

of traffic, on the basis of one ton of locomotive doing double the damage of one ton of the balance of its train. The question of the exact ratio of damage is an intricate one and would require more data than the committee has at present. There is no strong probability that the average axle load of locomotive and tender will reach the exceptionally heavy loading given for the extra heavy Mikado type in the report for many years, even if it ever does, and the modern consolidation will, in the majority of cases, represent the average to be considered in estimating values of locations.

It is interesting to note that by the proposed method of equivalent ton miles the passenger locomotive does as much damage as the balance of its train, while the freight locomotive does about one-third as much as the balance of its train on the average. The two extremes of freight service are represented by the Pittsburgh & Lake Erie, which with its low grades averages about 16.5 tons of cars and contents to each ton of locomotive, and the Denver & Rio Grande with its very heavy mountain gradients averages about 3.9 tons cars and contents per ton of locomotive. The extremes in passenger service are the New York, Chicago & St. Louis, averaging 3.15 tons passenger cars to one ton of locomotive, and the Chicago & Eastern Illinois Railroad, average 1.88 tons per locomotive ton.

In former practice the locomotive has been frequently considered as affecting a track in a fixed ratio to the balance of its train, but examples above will show the inconsistency of using such methods. It is to be hoped that data will become available to fix the factor with more certainty than the one assumed in this report.

Discussion on Economics of Railway Location.

W. J. Wilgus, consulting engineer: I have been much interested in reading the report of the Committee, especially the part bearing on the suggested method of segregating certain items of maintenance expenditures between passenger and freight service. It would seem that this point has a vital bearing not alone on economics of railway location, but also on another matter that is at least equally important.

The ascertainment of reasonably accurate costs of transporting passengers and freight is becoming increasingly necessary as a basis for resisting improper rate reductions, and for securing higher rates where their fairness can be proven. While a few of the I. C. C. classification items of maintenance fluctuate in proportion to train mileage handled, the majority of them are, as stated by the committee, directly or indirectly affected by the gross weight ton mileage that rolls over the rails. The question then arises—should the actual tonnage be taken, embracing locomotives, cars and contents, or should an attempt be made, as recommended by the committee, to make allowance through "equivalent ton mileage" for excess damage assumed to be done to track and structures by the higher speed passenger trains and by locomotives as compared with the load they haul?

As regards the comparative effect of passenger and freight trains, it is the opinion of the writer that, generally speaking, there is no appreciable difference, if in considering the higher speeds in passenger service equal attention is paid to destructive agencies peculiar to the freight service, such as drippings from coal and refrigerator cars, imperfections of equipment, heavier wheel concentrations, twisting action of locomotives at slow speeds, littering of roadbed and the fouling and destructive action of the products of combustion of inferior grades of coal used in freight service. Corrosive drippings are detrimental to floor beams and stringers and solid floors of bridges; to track fastenings such as spikes, tie-plates, bolts and splices; and to rails, frogs and switches. Side bearings on freight cars are so stiff as to provide much less freedom of adjustment to varying track conditions than on passenger cars. This has been strikingly shown on tracks used exclusively for freight traffic, where trucks in passing from curve to tangent retain their slewed position and grind the outer rail for considerable distances.

Springs under freight cars are less delicately adjusted than on passenger cars, with correspondingly greater shock to track and structures, especially in the case of eight-wheel coal cars having 18,750 lbs. per wheel as contrasted with 12-wheel passenger coaches weighing but 12,500 lbs. per wheel. Superworn tires, flat spots on wheels, dragging brake beams and draft rigging, and similar imperfections peculiar to freight equipment, cause additional wear and tear. Slowly moving freight locomotives when exerting their maximum tractive force, cause a twisting action from side to side that tends to work track out of line as much or more than higher speed passenger trains.

Droppings from freight trains, such as lumps of coal, rubbish, loose doors and other broken parts, increase the danger and add to the cost of policing. Freight locomotives consume more coal and use a poorer grade of fuel, and the resulting larger volume of cinders, gases and smoke fouls the ballast, corrodes metallic structures, and injures paint on buildings, bridges and signals to a greater extent than with passenger power. Freight locomotives under load stop and start more frequently, causing slipping of drivers that blisters and wears the rail. Local freights do more or less switching on main tracks and at stations, with accompanying wear and tear on track and structures.

On many railroads both "drag" and preferential freight trains on certain divisions are run at high speeds, in order not to interfere with the passenger service, and any fixed rule for calculating "equivalent ton mileage" would have to be varied to meet these frequent conditions.

It therefore seems clear that relative speeds of passenger and freight trains are so variable and the instances in which the latter are more destructive to track and structure so numerous, that any attempt to arbitrarily fix the percentage that one exceeds the other would lead to questionable results. Judgment, which in any event must guide a decision, would seem to lead to the conclusion that, taking all these facts into consideration, the added cost of maintenance chargeable to passenger service by reason of higher speeds is practically offset by many features incident to the slower speed traffic.

As to the comparative effect of locomotives and of the load they haul, it is possibly true that the former cause somewhat more damage per ton than the latter, but not to the extent that might be imagined. For instance, taking two loaded coal cars weighing 150 tons, their smaller diameter wheels, less perfect construction and maintenance, and drippings and droppings, may be said to go far toward equaling the twisting and corrosive effects of a locomotive of the same weight; and in passenger service the smaller wheels and tail-end side swing may be considered as going far toward equaling the destructive action of the locomotive.

To guess that the locomotive, including its tender, creates twice as much destructive action per ton of gross weight as the load it hauls, may yield a result more in excess of the truth than the making of no allowance may understate the truth.

Summarizing, in the absence of precise data, and taking into account the complexity of the problem, is it not fair to say that under average conditions a gross weight ton of passenger train creates the same destructive effect on track and structures as a gross weight ton of freight train; and that an attempt to assign constructive tonnage to portions of the rolling load as the measure of their assumed excess wear and tear on track and structures, will result either in complications and contradictions, or in so many variations in the formula as to make the exceptions prove the rule?

A. K. Shurtleff, committee chairman: It is sometimes supposed that the problems of this committee can be reduced to an exact science and that simple formulæ can be deduced which will be mathematically correct in all cases when applied to the problems regardless of the varying conditions. This is impossible, owing to the fact that, were it possible to determine accurately the proper coefficients for each of the variables under different conditions, the formula would become very complex, and the judgment of the engineer would have to be exercised in selecting the particular value of each coefficient for the condition which he thinks may exist. Such complicated equations would probably lead to no greater accuracy than the approximate simpler formulæ such as this committee is attempting to establish.

We are trying to formulate **methods** for analyzing the problems of economics with reasonable accuracy. In so doing, we give equations which, to our best knowledge, cover average conditions. We expect that many roads will find the values of certain terms of the equations different under their conditions of operation from those given by this committee. In such cases we believe that by the use of the methods to be proposed by this committee and the cofficient values as they find them, satisfactory results will be obtained in weighing the relative economic values of various locations.

In our present report we have attempted to give a method for analysis of maintenance of way accounts, hoping at a later date to simplify to an equation form of sufficient accuracy for the field engineer. We are attempting to analyze the items which are affected by volume of traffic on the basis of equivalent ton mileage, reducing locomotive tonnage and passenger train tonnage to an approximate equivalent of freight car tonnage, using multipliers for each, which, in our present judgment, appear to represent the relative damaging effects of a ton of each class, as compared to the average effect of one ton of freight car and load.

In this connection I desire to call attention to the criticism of W. J. Wilgus, and his suggestion that actual tonnage be used in dividing between the two classes. The points raised

by Mr. Wilgus showing expenses created by freight service which do not apply to passenger traffic are excellent. At the same time the points brought out about the locomotives can be used as an excellent argument in favor of considering one ton of locomotive as producing greater damage than a ton of car and contents.

There is wide difference of opinion with reference to the relative damage per ton of passenger train when compared to a ton of freight. It is certain that our roads require a much higher grade of maintenance, both in labor and material, to take care of the higher speeds of passenger service than they would if the entire tonnage over the rails was freight. Unfortunately, the tests at St. Louis covering counterbalancing were only made on Atlantic Passenger Locomotives of the so-called balanced compound type, no such tests being made on simple locomotives.

With the exception of the Cole engine, the nosing of these locomotives increased materially with the velocity, and in the Baldwin balanced compound was as great as 0.74 in. per revolution at 240 r. p. m. or 56 m. p. hr. In this locomotive at the same speed the load on each wheel of the first set of drivers became very light through one-quarter of each revolution and returned abruptly in about one-eighth revolution. At 320 revolutions one forward driver left the rails. It is well known that counterbalancing can be most satisfactorily accomplished in four-cylinder locomotives, but statistics show that less than 7 per cent of the Atlantic and Pacific type locomotives have 4 cylinders, the balance being simple. The great bulk of passenger locomotives are of the simple engine type and at the high velocities undoubtedly cause much greater disturbance to the track than the balanced compound cited above.

In view of these disturbing forces at high speeds and the necessity of higher grade of maintenance, it would seem that the costs of maintenance in those accounts affected by the volume of traffic would be greater per ton for passenger service than for freight and that the equivalent ton mileage principle should be used in the analysis of costs for these accounts.

The factors for reducing to equivalent ton mileage may vary somewhat. Data covering several years' operation on a 4-track road having 2 tracks devoted to each class of traffic would help materially in fixing the relative values.

(It was moved and seconded that conclusion 2 under Revision of Manual in the report be accepted.)

L. C. Fritch (C. G. W.): This subject is something that is so much involved that it is very hard to fix any formula or rules that will fit all conditions. I believe some resistances will increase with the speed and others will decrease with the speed, but it looks to me like the limits between 7 and 35 m. p. h. are rather high. The limits ought to be from 5 to 20 m. p. h. The higher limits are really the more practicable for freight train speed, and I think Mr. Begien reaches the conclusion that one is almost forced to reach, that it is almost impossible to establish any formula that will fix the train resistance; that with all the numerous tests that were made, according to his report, it is very hard to get anything that will serve as a guide. Of course, the main difficulty is that there is such a vast difference in equipment, and it is not always possible to fix any definite resistances. My own opinion is that the railroads of this country are going to extremes in tonnage. They are overloading trains. I have always believed that there is an economical maximum tonnage which is very much below the maximum tonnage which locomotives are able to draw. I think that many roads are expending more money in overtime and interference with traffic than would be the case if they established an economic loading, which would be much better than the maximum tractive power of the locomotive; the tonnage could be used in such cases with less delay and interference.

F. S. Stevens (P. & R.): I might say on the question of tonnage it appears to me to be a self-evident fact that the most economical tonnage to handle is that which will enable an engine to deliver the greatest tonnage from one point to another within a given time at the least expense. This holds true, no matter whether you wear your engine out in one month, or one year, or ten years—the quicker you wear it out the better. The whole question is to move the tonnage, the most of it, in the least time, at the least expense; that is the whole thing to be worked out.

C. P. Howard (I. C.): I have recently used this data in calculating the time and fuel consumption and other items for a division of 130 miles. In a case where it would be practicable to haul a 5,000-ton train at about 3.5 m. p. h. over the proposed 0.3 per cent. grade, it was found a 4,000 train would be just about the economical limit. The fuel consumption per ton mile remains practically the same for the 5,000-ton train as for the 4,000-ton train. The time increases a great deal. In fact the time for the 4,000-ton train was about 15 per cent greater than the time for a 2,700-ton train. The fuel consumption for the 2,700-ton train, as calculated from the information given by Mr. Shurtleff in his bulletin, checked out very closely with that given by the superintendent in his estimate.

F. S. Stevens: One of the principal questions is interference. The tonnage rating that is worked out absolutely correctly, which will give the best results and move the greatest tonnage in the least time, is indefensible in many cases, because to put that tonnage over the road means that you cannot put anything else over it. The local freight and the passenger service must be put out of commission. The tonnage trains can only move to the limit of the sidings, and they must have a limit of speed, and if they get into a hole in some place on account of the preferred service, they cannot get out. All these things have to be considered.

(Conclusion 2 was then adopted as revised.)

Mr. Shurtleff: We propose to change conclusion 7 of the Manual to agree with Mr. Begien's conclusions from dynamometer tests, presented elsewhere in this issue, except that we desire to omit his conclusion 2, and state under D in conclusion (1): "The following formulae are practicable where train has been in motion at least 15 minutes." Then give the formula for A rating, which is the same as the present formula given in 3, or practically the same; the formula for B rating, the formula for C rating, and the formula for D rating. Those give the ratings for different conditions of temperature. Then insert the table shown on page 615 of the Manual. In that way we cover in the one conclusion what was covered in the two conclusions at the previous meeting.

L. C. Fritch: How are we going to get the train in motion the first 15 minutes? I cannot see that there is any practical use in that. Of course, they could heat up the journals, but they could not put on additional tonnage after the train had been in motion fifteen minutes. So of what use is the resistance at that time? It is probably well enough for information, but I cannot see that it is of any practical value to us.

G. D. Brooke (B. & O.): As I understand the adaptation of this formula to actual practice, a certain speed will have to be assumed and that would be the speed that probably would be attained on the ruling grade after the train had been in motion 15 minutes, in starting, of course, and for the first 15 minutes of the run. If the run during that period is on the ruling grade, the train would proceed at a considerably lower speed than the assumed speed, but that lower speed for a period of 15 minutes would not appreciably affect the running of the train over the division; so the value of the formula would not be affected.

Mr. Shurtleff: The rating is always given as two things that govern the time allowable over the district, and your ruling grade. The time allowable over the district would fix the speed on the ruling grades, and this speed would in many cases not fall below 6 m. p. h., and more often it runs to 8 and 10. At 10 m. p. h. the locomotive has a great deal less tractive power than it has at 5 m. p. h. In spite of the fact that we have in the past assumed that the locomotive could work with the reverse lever down in the corner, up to 8 or 10 m. p. h., we have yet to find a fireman who can fire the modern locomotive under these conditions. Therefore, when you get to working at 7½ or 8 m. p. h., your draw bar pull is much less and during the early few minutes of the run the locomotive has greater power to overcome the starting resistances. I do not think it would make so much difference at mere stop for a signal, where the journals would not have a chance to cool down.

Mr. Sullivan: It is unfortunate in a great many cases that the operating department and the engineering department do not work closer together than they do. I do not think this committee can go too far into the other fellow's department. Take a practical case. Suppose we have a superintendent who wants to load everything up to the very last notch, and we have some 0.4 per cent grades that could possibly be reduced to 0.3 per cent. We do that work and spend thousands of dollars on a division. The next superintendent comes along and says, "We are loading too high; we are going to load at a 10 or 15 per cent reduction." The chances are that the money that you have spent on the grade reduction has been thrown away for the reason that if the former superintendent were loading for the short grades, the loads could be carried over. I am very much opposed to any restrictions of this committee in the way of figuring out economics and going into the costs, and also the method of transportation. That problem would have to be solved by each road itself. They must get together with the operating

and engineering departments, but the general information that this committee can give should not be restricted.

A. J. Himes (N. Y. C. & St. L.): In pursuing the subject along this line, it is primarily the duty of the engineer to be thoroughly posted with the work of the operating department as it is actually done and to learn from it all that he can and to offer his assistance in any case where it appears that the best results are not being secured in the operation of the road. In many cases too sharp a division has been made between the different departments. The particular development of the present generation in all kinds of economic work has to do with co-operation. The great secret of success in large enterprises is to bring about accurate and hearty co-operation between the many units of an organization.

(The recommendation of the committee in the second paragraph of the Revision of the Manual was adopted.)

J. L. Campbell: I believe that a safe rule for a locating engineer to follow is to assume that the operating department will make a proper and efficient use of the plant, that the engineering department gives for the conduct of transportation.

The substitution of conclusions 1-4 under "Tonnage ratings" in Mr. Begien's Appendix B (published elsewhere in this issue) for conclusion 4 of the Manual was next considered.

J. B. Jenkins (B. & O.): There seems to be a considerable difference of opinion based on different results and tests, as to whether degree of curve increases the resistance, per degree, or whether it decreases it. In general it sems if you disregard all other conditions that a 10 deg. curve seems to require less compensation per degree than a 2 deg. curve, but I believe if we consider other conditions we will find the case to be quite the opposite. I think the reason why the 10 deg. curve seems to require less compensation is that, the speed at which the freight train passes over the 10 deg. curve is more nearly that for which the curve is super-elevated, while with a 2 deg. curve, the curve is liable to be elevated for fast passenger service and the freight train goes around it at a much slower speed, resulting in greater friction. The principal factor in changing the rate of compensation should be the relation of the elevation of the outer rail to the elevation required for the average speed of freight trains. Undoubtedly there is more friction in swinging the truck on a 4 deg. curve than there is on a 2 deg. curve. I believe if all conditions were taken into account, that these figures should be more nearly reversed; that it should be more nearly 0.04 for the 2 deg. curve, 2,000 ft. long, and more nearly 0.03 for the 4 deg. curve 1,000 ft. long.

G. D. Brooke (B. & O.): It appears to me that there is confusion here between the degree of curve, and the central angle of the curve. The total compensation will be the same whether it is a 4 deg. curve, or a 2 deg. curve, but the rate per degree will be different. Take the example just cited, with a 2 deg. curve 2,000 ft. long, 40 deg. of central angle; your total compensation would be 1.2 ft. With a 4 deg. curve 1,000 ft. long, your compensation would be at the rate of 1.2 or the total compensation for the whole curve will be the same thing, 1.2. In other words your degrees of central angle would be constant, but your rate of compensation would increase with the degree of curve, while the length of your curve will decrease in inverse proportion.

J. L. Campbell (E. P. S. W.): I ask the committee to state the reasons for making the curve length a factor in determining the rate of compensation.

Mr. Shurtleff: There is only a portion of the train being subjected to the resistance at one time, and the draw bar pull of the locomotive is constant. If the whole train was subjected to the resistance it would mean that each ton of the train was subjected to that resistance, but in cases where only half of the train is subjected to that resistance, work out as Mr. Begien did, we think a less resistance would be suitable in each case.

S. S. Roberts (I. C.): Would it not be better to drop the word "super" in paragraph 3 of the conclusions from the word "Super-elevation?"

Mr. Shurtleff: The committee will accept that.

Mr. Brooke: There is one remark I wish to make for the information of the Association and that is that the dynamometer tests referred to in the paper of Mr. Begien embraced almost every conceivable class of line and traffic. The tests were made on lines having from 2 to 2.1 per cent. grades, with curves as high as 14 deg., and they were made over 0.3 per cent. lines, with maximum curvature of 4 deg., on which there was no passenger travel whatever. They embraced other high-speed lines having curves of 5 and 6 deg., with mixed traffic, and practically level lines having some curves as high as 9 to 10 deg. curves, on which the speed of passenger trains was high, and the speed of the freight trains was low.

E. Gray, Jr. (C. & O.): It has been suggested that compensation is not necessary in the case of minor grades or very light grades. I think that this view is wrong. Much mischief has been done and the possible train load of railroads cut down by the contrary practice. It often happens that a railroad might have long stretches of very long grades and only a few governing grades and that compensation has been carried out only on those heavy grades, and it occurs afterwards that those stretches of light grade become the governing grade either because helper engines are employed on the heavier grades, or the grades are reduced by changing the route.

M. L. Byers (B. & H.): I want to offer a suggestion to the committee. My idea is that curved resistance depends on three principal factors. The first is the degree of curvature, the second is the relation between the length of the curve and the length of the train, and the other in the super-elevation of the curve. The formula which the committee has offered us seems to agree pretty well, perhaps I should say very well, for the first two factors. I suggest that the committee keep in mind the matter of looking into the question of the effects of variation in super-elevation on the curve resistance in the future.

J. L. Campbell: I do not believe the curve length is the proper element to take into consideration in determining the rate of compensation. I think on a 1 per cent grade, if a properly compensated grade is one-half the length of the curve, that you must eliminate that part of the train which is off the curve.

Prof. W. G. Raymond (Iowa University): I think, from theoretical grounds, the curve resistance varies with the degree. Therefore, the compensation to be theoretically exact, to produce the effect that the chairman of the committee says he wishes to produce, namely, a constant pull on the draw-bar, or at least a constant effort of the locomotive, to produce that as nearly as possible, his compensation should vary with the curve resistance, and I think it is pretty well established that curve resistance must vary with the degree of the curve. I think that is evident, from the fact that a large part of this resistance is due to the twisting of the truck on the track, and that means simply the friction between the wheel and the rail, and that must be largely independent of the degree of the curve. In these days we are devoting a large part of our effort to the betterment of the submerged tenth, and it seems to me the submerged tenth that have four tracks are as well entitled to consideration as the 90 per cent of the roads who have only one track, and therefore it seems to me that in the committee's report, when it is finally made up, that there shall be rules for one track roads and other rules for four-track roads, and I believe the committee should take notice of that fact in making its conclusions.

(The new conclusions 1-4 were then adopted by vote of the association.)

Mr. Shurtleff: The conclusions presented in the main report are in reference to the present matter published in the Bulletin and attempt to lay down an approximate method of analyzing the maintenance of way expenses, particularly those expenses which vary with the volume of traffic. They are presented to aid in the analyzing of the expenses referred to, but this committee cannot feel it has hit the exact method. We believe, however, we have made a long stride toward a proper method of analysis.

Conclusion 1 was adopted.

Conclusion 2 and 3 were adopted as information.

L. S. Rose (C. C. C. & St. L.): Concerning conclusion 4, I do not believe as a general proposition that the passenger train is twice as severe on a track as the freight train. It depends somewhat on the speed. I believe that the passenger cars are kept in better condition than the freight cars and have fewer flat wheels. The damage to the track which causes repairs depends on the speed, and that should be taken into consideration.

L. C. Fritch: I have not any constructive criticism to make in this case, but it does seem to me before we adopt even as information a conclusion that may be as far reaching in its effects as this we ought to get all available data on the subject. We all know that efforts are being made to determine the cost as between passenger and freight service. If we establish a principle here that it costs twice as much to maintain the track for passenger service as for freight service I think we want to be very sure of our ground.

Mr. Shurtleff: The committee did not have any definite information on this subject but studied the question carefully. It is just merely a guess. This committee has got to stop work now on the advance study of this question until we get some means of going ahead and analyzing these accounts. We will be glad to receive all assistance from any of the roads that can be given us, in order to determine this question.

C. E. Lindsay (N. Y. C. & H. R.) We have a 4-track road, two tracks being devoted to passenger traffic, and two tracks being devoted wholly to freight traffic, although the passenger tracks are also used for high-speed freight traffic. If it was my guess, I would reverse the guess of the committee. I think the committee has been misguided by the effect of the train as a whole and the committee has overlooked the question of speed. In my opinion the design and maintenance of passenger equipment is far superior to that of freight equipment. In the passenger equipment we have 6-wheel trucks, with a very superior spring arrangement. In the freight service we have 4-wheel trucks and the spring arrangement is hard and rigid on the track.

Mr. Byers: I do not believe a fast freight train running at 60 m. p. h. is different in its effects from a passenger train running at the same speed, and my experience with the relative cost of maintenance of track under high and low speed traffic is that it depends mostly on the standard of the maintenance of the tracks as to the cost. The cost of track maintenance, as the result of deterioration under train service, is principally for surfacing, that is, the labor cost, and the labor cost of picking up a low joint, ⅛ in. low, is almost the same as picking up a joint ½ in. low. If you had trains running 60 to 70 m. p. h. you must maintain the joints more nearly to a perfect level than on a track where the trains run 30 m. p. h. Any examination of ordinary freight track will show that this element is taken into consideration and that the maintenance is much less perfect in that case than in the higher speed tracks.

Mr. Lindsay: The conditions of our roads are these: Up until 3 or 4 years ago the passenger tracks were sacred, but recently the density of traffic has increased to such a point that it has been necessary, in order to take care of the freight traffic, to run a great many freight trains, both of the slow freights and the fast freights, on these passenger tracks, and the effect on the cost of maintenance has been very marked. Mr. Byers calls attention to the sameness of cost in raising a small low joint or a very bad low joint. That is a question of comfort with relation to passenger trains and does not enter materially into this case.

(Conclusions 4 and 5 were referred back to the committee.)

WOODEN BRIDGES AND TRESTLES.

The Association directed that the outline of committee work for the year 1912 be as follows:

(1) Report on formulæ for use in determining the strength of sheet piling.

(2) Report on fire protection of wooden bridges and trestles.

(3) Complete report on the use of guard-rails for wooden bridges and trestles.

On subject No. 1 the committee reports progress.

On subject No. 2 the committee does not deem it advisable to make any recommendations, but submits its report as information.

On subject No. 3 the committee makes the following recommendations:

(1) It is recommended as good practice to use guard timbers on all open-floor bridges, and they should be so constructed as to properly space the ties and hold them securely in their places.

(2) It is recommended as good practice to use guard-rails to extend beyond the ends of the bridges for such a distance as required by local conditions, but that this length in any case be not less than 50 ft.; that guard-rails be fully spiked to every tie and spliced at every joint, the guard-rail to be some form of a metal guard-rail.

(3) It is recommended that the guard timber and guard-rail be so spaced in reference to the track rail that a derailed truck will strike the guard-rail without striking the guard timber.

(4) The height of the guard-rail to be not over one inch less than the running rail.

The committee recommends that the following subjects be assigned for the ensuing year:

(1) Complete report on formulæ for use in determining the strength of sheet piling.

(2) Report on the subject of docks and wharves.

I. L. Simmons (C., R. I. & P.), Chairman; W. S. Bouton (B. & O.), Vice-Chairman); H. Austill, Jr. (M. & O.), Henry S. Jacoby (Cornell Univ.), F. E. Bissell (A. C. & Y.), P. B. Motley (C. P. R.), R. D. Coombs (Cons. Engr.), D. W. Smith (H. V.), E. A. Frink (S. A. L.), W. F. Steffens (B. & A.), E. A. Hadley (M. P.), H. B. Stuart (G. T.), Hans Ibsen (M. C.), Committee.

APPENDICES.

Illinois Central:

All through bridges and high steel viaducts are being equipped with rerailing devices, especially where a high rate of speed is maintained. Some few high and long wooden structures have been equipped with rerailing devices. These rerailing devices are placed 12 ft. 6 in. from the end of the structure on the roadbed. The inside guard rail is continued out 20 ft. past the rerailing device, running to a point connected by a cast steel casting 2 ft. 3 in. long and bolted to casting with 2¾-in. bolts. The outside guard timber is connected near the rerailing casting with a steel guard rail 18 ft. 7 in. long, turned out at the end near the guard rail point 1 ft. 7 in. from the running rail. The rerailing device consists of two separate castings made of semi-cast steel. The casting between the traffic rail and the outside special guard rail is 5⅝ in. high and shaped in between both rails. The casting has a 10-in., flat-bearing surface. The casting between the traffic rail and the inside guard rail is 5 ft. 8 in. long and 9 31/32 in. wide. It has a rib 3½ in. high at center running down to a flat surface at each end. This rib is 2½ in. at center of casting from ball of main rail, beveling back at the ends of the casting 5½ in. to the guard rail. These devices have proved effective. An engine weighing 100 tons was rerailed on a high viaduct while running at 30 miles an hour. Freight cars have been rerailed on another high viaduct and on a long through truss bridge.

Pittsburgh & Lake Erie:

A rerailing device at the south end of the bridge over the Youghioghany River at McKeesport has rerailed cars frequently, as evidenced by cut ties approaching the rerailing device and vanishing at that point. Other cars have been rerailed at the device placed at the end of the bridge over the Mahoning River at Lowellville Junction. At both of the above points the absence of the rerailing device would undoubtedly have resulted in the destruction of the bridge.

Philadelphia & Reading:

When a No. 6 frog is used, the guard rails on the approach end are extended 41 ft. 3 in. On the trailing end they are extended 20 ft. and the rails bent until the ends are 18 in. apart. When a No. 8 frog is used, the guard rails are extended 54 ft. 7 in. on the approach end. On the traiing end they are extended 35 ft. and bent as above. When a No. 10 frog is used the guard rails on the approach end are extended 68 ft. On the trailing end the guard rails are extended 50 ft. and bent as above. On single track the frog points shall be used on both ends. On double track the frog is used only on the ends facing traffic.

Lehigh Valley:

On double track guard rails extend 200 ft. from the bridge on approach side and 30 ft. on the leaving side, where the speed is over 35 miles an hour. When the speed is less than 35 miles an hour the guard rails extend only 100 ft. on the approach side. On single track the guard rails extend 100 ft. or 200 ft. from the end of the bridge, depending on whether the speed is low or high.

Chicago, Rock Island & Pacific:

The minimum length for the extension of guard rails beyond the bridge is 60 ft. In cases where the span has a pile or timber trestle approach, the guard rails should extend over this approach and 60 ft. beyond, providing the approach is not more than 300 ft. long. In case the approach is more than 300 ft. long, the guard rail should extend 300 ft. from the end of the bridge.

Lake Erie & Western:

Within the last two years we have had five derailments which we consider would have been considerably more serious if it had not been for the guard rails. In one case the derailed truck struck the point of the guard rails within a few inches of the center of the track and the truck was pulled

over so that the car safely crossed the bridge and the wheels between the running rail and the guard rail.

Pennsylvania Lines West:

We know of cases where derailed wheels have crossed safely over a bridge on which there were guard rails, when the train would undoubtedly have been wrecked had no guard rails been provided. As a specific instance, I abstract from report of a derailment on the Ohio Connecting bridge (Pittsburg), on March 2, 1907:

"This bridge has a total length of 4,520.2 ft., and crosses both channels of the Ohio river, Brunot's island, and about 1,400 ft. of the city, north of the river, at an elevation of 50 ft. above high water level.

"On the above date, a westbound freight train approached the bridge at a speed of about 19 miles an hour. The train comprised 32 cars, and the third car from the rear was a 70,000 lbs. capacity coal car, loaded. About 30 ft. from the east end of the bridge a flange, on the front wheel of the rear truck of the above car broke, on an 11-deg. approach curve, and the car was derailed at a point about 197 ft. on the bridge. From this point the derailed truck ran over the bridge about 740 ft., until the train was stopped by the wrecked floor and separated air hose.

"The running rails on the bridge were 85 lbs. per yard, and in addition to the standard outside timber guards there were inner guard rails of old 85 and 80 lb. rail, placed 8 in. in the clear, inside of the running rails, and spiked to every other tie."

The conclusion of the report stated: "That the presence of the inner guard rails, beginning at the east end of span No. 3 (through span, 416.1 ft. long), undoubtedly prevented a serious accident to this span, which might possibly have been its destruction. That the continuance of the inner guard rails across span No. 3 and the deck spans controlled the movement of the wrecked truck, and had it not been for the old ties on the deck spans, might possibly have prevented further accident.

"On span No. 3 the north wheels sheared the spikes on the north of inner steel guard rail, and the lateral force of the wheels against this guard rail bent over the spikes on the south, moving the rail inward an inch or two. When the train reached the deck spans, the ties on which were nine years old, the inner steel guard rail was moved inward as much as a foot in places.

"Inner guard rails of steel rails are not desirable for bridges of this length or character, because the spikes are sheared by derailed wheels, and guard rails moved inward, even on perfect ties.

"Inner guard rails, consisting of timber, 7x8, laid flat and lock-dapped to the ties, should be used."

Chicago, Milwaukee & St. Paul:

We have had a number of cases of derailments on bridges which have clearly and unequivocally demonstrated the value of the guard rails, and especially of the type we use. Several of these cases have been on important bridges, where the result of a car breaking through or running off the floor would have been a very serious matter. One case was a heavily loaded refrigerator car, which passed over three 200-ft. spans on a 6-deg. curve. Another case was on one of our Mississippi River bridges, where the derailed wheels traveled over several spans, and a considerable distance of the approach, part of which was on a curve. In both of these cases there was no injury to the structure, and no complete wreck of the car. We are firmly convinced that the type of guard rail used was responsible for our escaping with so little damage.

Norfolk & Western:

On one timber trestle, 200 ft. long, we put a gravel floor as a trial three years ago. As this bridge is on a curve, we have had to keep the gravel from shaking down to the low rail. This is done by the trackmen. It is a defect in the plan, and longitudinal obstructions should be placed to prevent the gravel from shaking down. Before fireproofing this trestle we had eight to ten small fires a month and one complete destruction, but have had no fires since it has been fireproofed.

Chicago, Rock Island & Pacific:

In 1909 we started the use of ballasted deck trestles. For the year ending June 30, 1910, we had 368,253 lin. ft. of pile trestles, including approximately 7,500 ft. of ballast deck trestles. During this year we had 88 fires. The statistics for 1911 have not yet been completed, but we now have approximately 10,000 lin. ft. of ballast deck trestles. For the nine months ending March 31, 1911, the fire loss amounted to $6,444.71. We also have a large number of trestles having "fireproof deck," which consists of 1-in. thick boards between the ties, covered with crushed stone, gravel or slag. We have no means of telling just how much the use of fireproof or ballast deck trestles has decreased our fire losses, except that in not a single case since we have adopted their use has a fire been reported on any of them.

Chicago, Milwaukee & St. Paul:

This company uses two methods of protecting the floors of timber bridges from fires originating from locomotives. No method has been adopted for protecting timber floors on steel bridges. One of the methods of fire protection used by this company consists in spreading a layer of gravel over the ties to a depth of about 3 in. The gravel is supported between the ties by nailing 1-in. boards either over the openings or between the ties. The guard timbers are protected by strips of galvanized sheet iron. The other method consists of laying strips of galvanized iron so as to completely cover the ties and guard timbers.

Although no means have been adopted by this company for protecting the timber floor of steel bridges, the danger aris-

FIRE PROTECTION ON WOODEN BRIDGES AND TRESTLES.

Railroad.	Method Used. Timber Bridges.	Method Used. Steel Bridges.	Have you ever suffered from a fire loss on bridges fireproofed by your method? If so, state where fire originated.	Give No. of Lin. Ft. Fireproofed. Timber Bridges.	Give No. of Lin. Ft. Fireproofed. Steel Bridges.	Give Approximate Cost per Lin. Ft.	Remarks.
S. P. & Seattle	Gravel	None	Yes. Burning rubbish beneath	20,000	......	40c	
A. T. & S. F.	Gravel	None	Yes. Fire caught in piling	6,000	......	50c	
Pitts. S. & Nor.	Cinder or clay	None	No	1,000	......	5c	Method abandoned account rotting ties and str's.
Norfolk & Western	Gravel	None	No	200	......	50c	
El Paso & S. W.	Rock	None	Yes. One caught in deck	......	......	......	Method abandoned for solid floor.
Illinois Central	2-in. ballast	2-in. ballast	No	2,000	1,600	40c	
C. R. I. & P.	Gravel	None	No	......	......	30c	
C. M. & St. P.	3-in. gravel, gal. iron	None	......	......	......	Gravel, 50c; Gal. iron, 75c	Guard timbers protected by gal. iron.
Virginian	Gal. iron on high trestles	None	Yes	47,417	......	......	
Maine Central	Clapp's fire resist paint	None	No	1,330	......	......	
Mich. Central	Gravel or rock, gal. iron	None	No	1,160	......	Gravel, 70c; Gal. iron, 75c	
Great Northern	Gal. iron, gravel or rock	Gal. iron proposed	......	Entire System	None	Gal. iron—70c old plan, 97c new plan; Gravel, 32c	
P. & R.	Sheet iron	None	......	......	......	......	
N. C. & St. L.	Gal. iron	None	Yes. Occasionally	94,548	......	40c	
L. & N.	Gal. iron	None	......	......	......	......	
Mo. Pac.	Gravel, gal. iron	None	......	10,000	......	Gravel, 90c; Gal. iron, 50c	
M. & St. L. and Ia. Cent.	Gal. iron	None	......	......	......	50c	
G. C. & Santa Fe	Gal. iron	None	None in deck. Few in piling	......	......	30c	

ing from fires on timber floors on deck girders has been eliminated on all of the more recent deck girder bridges by the use of either reinforced concrete slab ballast floors or creosoted timber ballast floors.

This company has two instances on record of bridge fires starting on bridges with fire protection. The first instance was on the Pacific Coast extension, where a bridge protected by gravel was destroyed. It is supposed that the high winds prevalent in this particular locality had blown the finer particles of ballast away and had shifted the coarser, thus leaving spots unprotected. The second instance occurred on a bridge which was protected by sheet iron only between the rails. In this case the fire started on the guard timbers.

At the close of the season of 1910 this company had protected 47,417 ft. of timber bridges against fire. At the close of the season of 1911 it is expected to have about 80,000 ft. of timber bridges so protected. In addition to this, all of the timber bridges on the C. M. & P. S. have been protected. During the period between January 1, 1911, and August 25, 1911, there has been about 50 per cent. less fires reported, caused by locomotives, than for the corresponding time during 1910.

Wherever headroom is sufficient, we use a ballasted trestle. No fireproofing of open-deck trestles is provided, but grass and rubbish are kept away from the piles.

Pennsylvania Lines:

On four of the nine operating divisions of this company fire protection is provided on some of their bridges. One division covers stringers between the ties and tops of caps with galvanized iron, projecting 1 in. over each side of the stringers and caps. One division formerly covered the tops of stringers between and under the ties with tin, but has discontinued the practice, as when the tin rusted through or broke and a spark passed through the opening to the dry timber beneath, the fire was difficult to reach, and in putting it out the fireproofing was entirely destroyed. This division has recently fireproofed the floor of one bridge over a street by attaching on top of the plank floor old Winslow car roofing, scrapped at the shops during the repair of cars. This protection has so far been satisfactory.

A third division covers the stringers with galvanized iron. A fourth division covers the deck from guard rail to guard rail with galvanized iron, running the sheeting over the guard rail and 3 in. or 4 in. outside. These sheets do not run under the rail, but lap over the flanges. They have also fireproofed one bridge by covering the tops and sides of each tie between the guard rials and the guard rails themselves with galvanized iron sheeting.

Where only the stringers and caps are protected, the protection of the stringers only applies to wooden bridges. The caps of bents supporting steel bridges are protected. On divisions where the entire deck has been fireproofed, this fireproofing has been done on both timber and steel bridges. We have not suffered any severe fire losses in the decks of bridges fireproofed, but one dangerous fire is reported with several small fires originating in the piling.

Reports from the four divisions on which some fireproofing has been applied show the total length of bridge so protected to be about one mile, or a small proportion of the total number of bridges on these divisions.

The division on which the tops of caps and stringers are covered with galvanized iron, projecting 1 in. over the sides, reports 75 per cent. decrease in the number of fires on bridges so protected. The other divisions report that, on account of the recent adoption of self-cleaning ash pans, which have largely increased the number of fires, statistics cannot be furnished.

The cost of protecting the tops of stringers between the ties and tops of caps with galvanized iron, projecting 1 in. over the sides of each, is reported as 22 cents per linear foot of track. The cost of protecting the deck with old Winslow car roofing is reported at 10½ cents per linear foot of track, for labor only. The cost of protecting the entire deck with galvanized iron sheeting to line 3 in. or 4 in. beyond the outside wooden guard rails varies from 79½ cents to $1.88 per linear foot, depending upon the location and size of bridge. This fireproofing was applied by a contract tinner and roofer.

(Conclusions 4 and 5 were referred back to the Committee.)

Discussion on Wooden Bridges and Trestles.

I. L. Simmons, Committee Chairman: I move that conclusion 1 be adopted as good practice.

J. L. Campbell: Is this report intended to cover the wooden guard rail outside of the track rail only?

Mr. Simmons: This is for the guard timber, and the guard timber is considered as the guard rail on the outside of the bridge.

(Conclusion was adopted.)

Mr. Rose: Is it the recommendation of conclusion 2 to have guard rails on all bridges?

Mr. Simmons: Yes.

Mr. Rose: I think that is going a little too far. Extending that reason a little bit, you will want a guard rail on every fill, and you will have the railroad with a guard rail from one end to the other.

C. E. Lindsay: I suggested the use of the words "guide rail" for this inner rail. Its purpose is to guide derailing wheels past the point of danger. When you look in the Manual for a definition of guard rail you will find it is a longitudinal member, usually a metal rail secured on top of the ties inside the track rail to guide derailed wheels. Our understanding of guard rail is to prevent wheels from being derailed, and I think there should be a definite term to show that the terms "guard timber" and "guard rail" are used indiscriminately and improperly. I am certainly opposed to the using of guard rails at all bridges. The use of a guide rail is to minimize the effect of a derailment in that particular locality. I think that the Dominion of Canada has done a very sensible thing in confining the use of guard rails to openings more than 50 ft., but I think it is necessary to go further. The object of the guide rail is to minimize the effect of derailments at points where there is a structure which might be damaged by the derailed car or where the curvature is excessive, or the speed grade, or where the height of an opening into which a vehicle might fall would be so great as to make a terrible calamity, or where the clearances are close and the speed excessive.

There is no sense in putting in an inner guard rail where there are turnouts at both ends. That would not minimize the result of derailment. Take a point at slow speed where a derailed wheel would do no harm, a guide rail is of no use and I hope the committee will reconsider this action and seriously consider a definition of the term "guide rail."

Mr. Loweth: I am opposed to any recommendation that we should put guide rails or guard rails, whatever they may be termed, on all bridges. It is an unnecessary expense, and is not in accordance with the facts or practice as indicated in the tabulation of the statement of the various roads in the committee's report.

Mr. Campbell: I agree with Mr. Loweth and Mr. Lindsay about the requirement for guard rails on all bridges. Many bridges are only 14 ft. long. Referring to page 664, I think the committee has shown what it intended to say in the recommendation. I raise a question about the necessity—in fact I am of the opinion that the guard rail on the outside of the bridge is a source of danger. I think that any guard rail outside of a rail has a tendency to aggravate the position of the derailed truck and to slew it across the track. I believe the guard rail at the end of the bridge should be removed and that we should depend entirely on the guide rails instead of the running rails.

R. C. Sattley (C. R. I. & P.): As superintendent of bridges and buildings for some 11 years on a railroad, it is my opinion that it is necessary to protect truss bridges with an inner guard rail, and we always advocate the putting of the inner guard rail 150 ft. from the end of the bridge. We have always followed this practice.

C. E. Smith (M. P.): The Missouri Pacific has about 800,000 lineal feet of bridges, and about 10,000 bridges. If guard rails were put across these bridges, and for 50 ft. from each end of each bridge, there would be about 1,800,000 ft. of track to protect, which, at a cost of 75 cents per lineal foot, would be something over $1,250,000, which at 6 per cent would be somewhere around $80,000 a year increased interest charged to the railroad for so protecting the bridge. There have been some derailments that have caused wrecks on bridges and trestles on railroads, but I do not know of a case where an inner guard would have prevented derailments or, if the guard rails had been there, would have eliminated the damage caused by these wrecks. The railroad company would still be away behind on the investment.

Mr. Simmons: I do not see that the recommendations carry the same effect that a state law would. It is not a question whether a railroad can afford to do it or not, but a question whether the damage to the structures in the past has warranted putting them on. So far as the short length of bridge is concerned, you can have as disastrous a wreck on a 15-ft. bridge as on a 500-ft. bridge. The length does not make any difference; the location might make some difference. That is to be determined by the man who has the matter in charge.

Mr. Rose: I think the question of guide rails is pretty largely a matter of sentiment. I have known of some derail-

ments where there was a guide rail and it had on effect. The outer timber did the work. I hope this convention will not rule that guide rails are necessary. I do not believe they are necessary, judged by the amount of good they serve.

Geo. W. Andrews (B. & O.): I take exception to what Mr. Rose has said. I know from practical experience that the inner guard rail is of decided benefit. We have had a number of derailments, and if it had not been for the inner guard rail the engine and possibly a large number of cars would have gone down the embankment.

Mr. Loweth: It seems absurd, on a deck bridge, where the deck girder bridge or deck pile and trestle bridge, that we should put in 10, 30 or 40 ft. long, over a shallow opening, that we should put in guard rails and extend them out 30 to 50 ft. at each end. It means that the protection that we put in at the ends is more than the protection on the bridge. If it is necessary to put in protection of that kind on short, shallow bridges, why don't we put it in over the miles of high embankment that we have, where the consequences of derailment would be much more serious than would be the case in many shallow bridges?

H. T. Porter (B. & L. E.): The inside guard rail was for the purpose of guiding a derailed wheel when the cars were 60,000 lbs. capacity. By putting in guard rails carefully, we did have some confidence in their being able to guide a derailed wheel, but since we have reached an axle-load on cars of from 35,000 to 40,000 lbs., the condition has changed. We have had cases where a derailed truck on an ore car has followed the track over 3 miles and missed but very few spikes and bolts. We have had other cases where the derailed car crossed the track and went down the bank in less than 60 ft. We have had cases where the car tore out a guard rail that was thoroughly spiked, and when the matter was under investigation I told our people that I believed that a black stripe painted along the ties would have done as much good as the guard rail. When your wheel is derailed and comes up against the guard rail, the situation is different from having the weight of the wheel on the rail. Any fastenings that I have been able to use were insignificant when they would have to resist the pressure of a derailed truck, when the load on the axle is 35,000 to 40,000 lbs., and where the truck has a tendency to cross the track.

(The conclusion was referred back to the committee.)

Mr. Loweth: In conclusion 3, I would like to suggest that the committee add after the words "guard rail," in the first line, "when used," so that it will read: "It is recommended that the guard timber or guard rail, when used, be so spaced," etc.

The President: The committee accept that.

(The motion to adopt Conclusion No. 3 was then carried.)

J. B. Jenkins (B. & O.): I move to amend conclusion 4 by inserting "inside guard rail must not be higher, or over one inch lower than the running rail."

The President: The committee accepts that.

(Conclusion 4 was then adopted as amended and the committee was excused.)

UNIFORM GENERAL CONTRACT FORMS.

The Committee was instructed to complete its report and submit the General Construction Contract. In accordance with the suggestions made at the convention in 1912, the secretary of the Association had a draft of the proposed form printed and sent a copy to the senior officer of each railway having membership in the Association with a request for a criticism of the contract by the Legal department. Seventy replies were received, which may be classed as follows:

Number of Replies.	*Nature of Replies.*
One.	Thought it impractical to draw a uniform contract form.
Six.	Preferred their own forms and made no other comments.
Thirty-five.	Approved of form, except in a few cases, where the lien clause was criticised.
Three.	Did not criticise, two of these being Canadian roads.
Twenty-five.	Made more or less extended criticisms.

The secretary tabulated the replies, including both the criticisms and the corresponding clauses of other contracts. This information was used by the committee in revising the forms submitted for criticism. Many of these criticisms concerned the detailed wording of the various clauses, and but few of them disapproved of any of the provisions as a whole.

The plan of having an agreement form of two pages to be used by itself for unimportant work and to act as a binder for the "General Conditions, Specifications and Plans," was approved by the convention of 1912. This agreement form as presented was also approved. As the result of legal criticisms received the committee desires to recommend three amendments to this form, as follows:

In the third paragraph insert the words "except as hereinafter specified," making this paragraph read: "The Contractor shall furnish all necessary transportation, except as hereinafter specified, materials, superintendence, etc."

In the first line below the blanks left for the description of the work, insert after the word "attached," the words "identified by the signatures of the parties hereto" and eliminate the word, "as," making this paragraph read: "In accordance with the plans hereto attached, identified by the signatures of the parties hereto, or herein described, and the following general conditions, etc."

Add to the next paragraph the words "time being of the essence of this contract," making this paragraph read: "The work covered by this contract shall be commenced.......... ....and be completed on or before the............day of............., 191...., time being of the essence of this contract................"

The committee presents for approval:

(1) Amendments to form "A" as above.

(2) Form "B" as presented.

RECOMMENDATIONS.

(1) That standing committees which have prepared specifications be instructed to harmonize them with the approved contract form by the elimination of provisions which duplicate or nullify clauses of the contract form.

W. G. ATWOOD,
Chairman Committee on Uniform General Contract Forms.

(2) That the special committee on uniform general contract forms be discharged on account of the completion of the work assigned to it.

W. G. Atwood (L. E. & W.), chairman; J. C. Irwin, vice-chairman; C. Frank Allen (Mass. Inst. of Tech.), E. F. Ackerman (L. V.), Thos. Earle (Penn. Steel Co.), John P. Congdon (Cons. Engr.), R. G. Kenly (M. & St. L.), E. H. Lee (C. & W. I.), C. A. Paquette (C. C. C. & St. L.), H. C. Phillips (A. T. & S. F.), J. H. Roach, (L. S. & M. S.), C. A. Wilson (Cons. Engr.), H. A. Woods (G. T. P.), committee.

CONSTRUCTION CONTRACT.

A—AGREEMENT.

THIS AGREEMENT, made this............day of............ in the year...............by and between.............party of the first part, hereinafter called the Contractor, and ....party of the second part, hereinafter called the Company.

WITNESSETH, That, in consideration of the covenants and agreements hereinafter mentioned, to be performed by the parties hereto, and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The Contractor shall furnish all the necessary transportation, except as hereinafter specified, materials, superintendence, labor and equipment, and shall execute, construct and finish, in an expeditious, substantial and workmanlike man-

ner, to the satisfaction and acceptance of the Chief Engineer of the Company..

....
in accordance with the plans hereto attached, identified by the signatures of the parties hereto, or herein described, and the following general conditions, requirements and specifications, forming part of this contract.

The work covered by this contract shall be commenced... ....and be completed on or before the ....day of................191...., time being of the essence of this contract..

....

And in consideration of the completion of the work described herein, and the fulfillment of all stipulations of this agreement to the satisfaction and acceptance of the Chief Engineer of the Company, the said Company shall pay, or cause to be paid, to said Contractor the amount due the Contractor, based on the following prices: ....

....

This agreement shall inure to the benefit of and be binding upon the legal representatives and successors of the parties respectively.

IN WITNESS WHEREOF, The parties hereto have executed this agreement in..................the day and year first above written.

WITNESS:

B—GENERAL CONDITIONS.

Bond.

1. The Contractor agrees, at the time of the execution and delivery of this contract and before the taking effect of the same, to furnish and deliver to the Company a good and sufficient bond of indemnity to the amount of..........dollars, as security for the faithful performance, by the Contractor, of all the covenants and agreements on the part of the Contractor contained in this contract. The security in such bond of indemnity must be satisfactory and acceptable to the Company.

This bond shall remain in force and effect in such amount, not greater than that specified, as shall be determined by the Chief Engineer, until the final completion and acceptance of the work.

Contractor's Understanding.

2. It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way affect the work under this contract. No verbal agreement or conversation with any officer, agent or employe of the Company, either before or after the execution of this contract, shall affect or modify any of the terms or obligations herein contained.

Intent of Plans and Specifications.

3. All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be executed and furnished by the Contractor as if described in both these ways; and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intent thereof, the Contractor is to understand the same to be implied and required and shall perform all such work and furnish any such material as fully as if they were particularly delineated or described.

Permits.

4. Permits of a temporary nature necessary for the prosecution of the work shall be secured by the Contractor. Permits for permanent structures or permanent changes in existing facilities shall be secured by the Company.

Protection.

5. Whenever the local conditions, laws or ordinances require, the Contractor shall furnish and maintain, at his own cost and expense, necessary passageways, guard fences and lights and such other facilities and means of protection as may be required.

Rights of Various Interests.

6. Wherever work being done by Company forces or by other Contractors is contiguous to work covered by this contract, the respective rights of the various interests involved shall be established by the Engineer, to secure the completion of the various portions of the work in general harmony.

Consent to Transfer.

7. The Contractor shall not let or transfer this contract, or any part thereof (except for the delivery of material), without consent of the Chief Engineer, given in writing. Such consent does not release or relieve the Contractor from any of his obligations and liabilities under the contract.

Superintendence.

8. The Contractor shall constantly superintend all the work embraced in this contract, in person or by a duly authorized manager acceptable to the Company.

Timely Demand for Points and Instructions.

9. The Contractor shall not proceed until he has made timely demand upon the Engineer for, and has received from him, such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

Report Errors and Discrepancies.

10. If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality, or any errors in plans or in the layout as given by said points and instructions, it shall be his duty to immediately inform the Engineer in writing and the Engineer shall promptly verify the same. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

Preservation of Stakes.

11. The Contractor must carefully preserve bench marks, reference points and stakes, and in case of wilful or careless destruction, he will be charged with the resulting expense, and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

Inspection.

12. All work and materials shall be at all times open to the inspection, acceptance or rejection of the Engineer or his duly authorized representative. The Contractor shall provide reasonable and necessary facilities for such inspection.

Defective Work or Material.

13. Any omission or failure on the part of the Engineer to disapprove or reject any mork or material shall not be construed to be an acceptance of any defective work or material. The Contractor shall remove, at his own expense, any work or material condemned by the Engineer, and shall rebuild and replace the same without extra charge, and in default thereof the same may be done by the Company at the Contractor's expense, or, in case the Chief Engineer should not consider the defect of sufficient importance to require the Contractor to rebuild or replace any imperfect work or material, he shall have power, and is hereby authorized, to make an equitable deduction from the stipulated price.

Insurance.

14. The Contractor shall secure in the name of the Company and for its benefit policies of fire insurance on such structures and in such amounts as shall be specified by the Chief Engineer not exceeding..............

Indemnity.

15. The Contractor shall indemnify and save harmless the Company from and against all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against it, by reason of any act or omission of the said Contractor, his agents or employes, in the execution of the work by or in consequence of any negligence or carelessness in guarding the same.

Settlement for Wages.

16. Whenever, in the opinion of the Chief Engineer, it may be necessary for the progress of the work to secure to any of the employes of the Contractor any wages which may then be due them, the Company is hereby authorized to pay said employes the amount due them or any lesser amount, and the amount so paid them, as shown by their receipts, shall be deducted from any moneys that may be or become payable to said Contractor.

Liens.

17. If at any time there shall be evidence of any lien or claim for which the Company might become liable and which is chargeable to the Contractor, the Company shall have the right to retain out of any payment then due or thereafter to become due, an amount sufficient to completely indemnify the Company against such lien or claim, and if such lien or

claim be valid, the Company may pay and discharge the same, and deduct the amount so paid from any moneys which may be or become due and payable to the Contractor.

Work Adjacent to Railroad.

18. Whenever the work embraced in this contract is near the tracks, structures or buildings of this Company or of other railroads, the Contractor shall use proper care and vigilance to avoid injury to persons or property. The work must be so conducted as not to interfere with the movement of trains or other operations of the railroad; or, if in any case such interference be necessary, the Contractor shall not proceed until he has first obtained specific authority and directions therefor from the proper designated officer of the Company and has the approval of the Engineer.

Risk.

19. The work in every respect shall be at the risk of the Contractor until finished and accepted except damage or injury caused directly by Company's agents or employes.

Order and Discipline.

20. The Contractor shall at all times enforce strict discipline and good order among his employes, and any employe of the Contractor who shall appear to be incompetent, disorderly or intemperate, or in any other way disqualified for or unfaithful to the work entrusted to him, shall be discharged immediately on the request of the Engineer, and he shall not again be employed on the work without the Engineer's written consent.

Contractor Not to Hire Company's Employes.

21. The Contractor shall not employ or hire any of the Company's employes without the permission of the Engineer.

Intoxicating Liquors Prohibited.

22. The Contractor, in so far as his authority extends, shall not permit the sale, distribution or use of any intoxicating liquors upon or adjacent to the work, or allow any such to be brought upon, to or near the line of the railway of the Company.

Cleaning Up.

23. The Contractor shall, as directed by the Engineer, remove from the Company's property and from all public and private property, at his own expense, all temporary structures, rubbish and waste materials resulting from his operations.

Engineer and Chief Engineer Defined.

24. Wherever, in this contract, the word Engineer is used, it shall be understood as referring to the Chief Engineer of the Company, acting personally, or through an assistant, duly authorized, in writing, for such act by the Chief Engineer, and wherver the words Chief Engineer are used it shall be understood as referring to the Chief Engineer in person and not to any assistant engineer.

Power of Engineer.

25. The Engineer shall have power to reject or condemn all work or material which does not conform to this contract; to direct the application of forces to any portion of the work which, in his judgment, requires it; to order the force increased or diminished, and to decide questions which arise between the parties relative to the execution of the work.

Adjustment of Dispute.

26. All questions or controversies which may arise between the Contractor and the Company, under or in reference to this contract, shall be subject to the decision of the Chief Enginer, and his decision shall be final and conclusive upon both parties.

Order of Completion; Use of Completed Portions.

27. The Contractor shall complete any portion or portions of the work in such order of time as the Engineer may require. The Company shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of the work as taken or used, or any part thereof. If such prior use increases the cost of or delays the work, the Contractor will be entitled to such extra compensation or extension of time, or both, as the Chief Engineer may determine.

Changes.

28. The Company shall have the right to make any changes that may be hereafter determined upon in the nature or dimensions of the work, either before or after its commencement, and such changes shall in no way affect or void this contract. If such changes make any change in the cost of the work, an equitable adjustment shall be made by the Chief Engineer to cover the same.

Extra Work.

29. No bill or claim for extra work or material shall be allowed or paid unless the doing of such extra work or the furnishing of such extra material shall have been authorized in writing by the Engineer.

The price for such work shall be determined by the Chief Engineer, who may either fix a unit price or a lump-sum price, or may, if he so elects, provide that the price shall be determined by the actual cost, to which shall be added .... per cent, to cover general expense and superintendence, profits, contingencies, use of tools, Contractor's risk and liability. If the Contractor shall perform any work or furnish any material which is not provided for in this contract, or which was not authorized in writing by the Engineer, said Contractor shall receive no compensation for such work or material so furnished, and does hereby release and discharge the Company from any liability therefor.

If the Contractor shall proceed with such extra work or the furnishing of such extra material after reciving the written authority therefor, as hereinbefore provided, then such work or material, stated in the written authority of the Engineer, shall be covered, governed and controlled by all the terms and provisions of this contract, subject to such prices as may be agreed upon or fixed by the Chief Engineer.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the Engineer in writing, as aforesaid, the Company may then arrange for the performance of the work in any manner it may see fit, the same as if this contract had not been executed, and the Contractor shall not interfere with such performance of the work.

Property and Right of Entry.

30. The Company shall provide the lands upon which the work under this contract is to be done, except that the Contractor shall provide land required for the erection of temporary construction facilities and storage of his material, together with right of access to the same.

The Contractor shall not ship any material or equipment until he has received written notice from the Engineer that he may proceed with said work or any part thereof.

Unavoidable Delays; Extension of Time on Parts of Work.

31. If the Contractor shall be delayed in the performance of the work from any cause for which the Company is responsible, he shall, upon written application to the Chief Engineer at the time of such delay, be granted such extension of time as the Chief Engineer shall deem equitable and just.

Suspension of Work.

32. The Company may at any time stop the work, or any part thereof, by giving ten days' notice to the Contractor in writing. The work shall be resumed by the Contractor in ten days after the date fixed in the written notice from the Company to the Contractor so to do. The Company shall not be held liable for any damages or anticipated profits on account of the work being stopped, or for any work done during the interval of suspension. It will, however, pay the Contractor for expense of men and teams necessarily retained during the intervals of suspension, provided the Contractor can show that it was not reasonably practicable to move these men and teams to other points at which they could have been employed. The Company will further pay the Contractor for time necessarily lost during such suspension at the rate of ....per cent. per annum on the estimated value of all equipment and fixtures owned by the Contractor and employed on the work which are necessarily idle during such suspension, said rate of...........per cent. per annum being understood to include depreciation, interest and insurance. But if the work, or any part thereof, shall be stopped by the notice in writing aforesaid, and if the Company does not give notice in writing to the Contractor to resume work at a date within ....of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work so suspended, and he will be entitled to the estimates and payments for such work so abandoned, as provided in Section Thirty-eight (38) of this contract.

Expediting Work, Correcting Imperfections.

33. If the Chief Engineer of the Company shall at any time be of the opinion that the Contractor is neglecting to remedy any imperfections in the work or is not progressing with the work as fast as necessary to insure its completion within the time and as required by the contract or is other-

wise violating any of the provisions of this contract, said Engineer, in behalf of the Company, shall have the power, and it shall be his duty, to notify the Contractor to remedy such imperfections, proceed more rapidly with said work or otherwise comply with the provisions of this contract.

Annulment.

The Company, if not at fault, may give the Contractor ten days' written notice, and at the end of that time if the Contractor continues to neglect the work, the Company may provide labor and materials and deduct the cost from any money due the Contractor under this agreement; and may terminate the employment of the Contractor under this agreement and take possession of the premises and of all materials, tools and appliances thereon, and employ such forces as may be necessary to finish the work. In such case the Contractor shall receive no further payment until the work shall be finished, when, if the unpaid balance that would be due under this contract exceeds the cost to the Company of finishing the work, such excess shall be paid to the Contractor, but if such cost exceeds such unpaid balance, the Contractor shall pay the difference to the Company.

Company May Do Part of Work.

Upon failure of the Contractor to comply with any notice given in accordance with the provisions hereof, the Company shall have the alternative right, instead of assuming charge of the entire work, to place additional forces, tools, equipment and materials on parts of the work for the purpose of carrying on such parts of the work, and the cost incurred by the Company in carrying on such parts of the work shall be payable by the Contractor and such work shall be deemed to be carried on by the Company on account of the Contractor, and the Contractor shall be allowed therefor the contract price. The Company may retain the amount of the cost of such work, with..........per cent. added, from any sum or sums due or to become due the Contractor under this agreement.

Annulment Without Fault of Contractor.

34. (a) The Company shall have the right at any time, for reasons which appear good to it, to annul this contract upon giving thirty (30) days' notice in writing to the Contractor, in which event the Contractor shall be entitled to the full amount of the estimate for the work done by him under the terms and conditions of this contract up to the time of such annulment, including the retained percentage. The Contractor shall be reimbursed by the Company for such expenditures as in the judgment of the Chief Engineer are not otherwise compensated for, and as are required in preparing for and moving to and from the work; the intent being that an equitable settlement shall be made with the Contractor.

Notice; How Served.

(b) Any notice to be given by the Company to the Contractor under this contract shall be deemed to be served if the same be delivered to the man in charge of any office used by the Contractor, or to his foreman or agent at or near the work, or deposited in the postoffice, postpaid, addressed to the Contractor at his last known place of business.

Removal of Equipment.

(c) In case of annulment of this contract before completion from any cause whatever, the Contractor, if notified to do so by the Company, shall promptly remove any part or all of his equipment and supplies from the property of the Company, failing which the Company shall have the right to remove such equipment and supplies at the expense of the Contractor.

Failure to Make Payments.

35. Failure by the Company to make payments at the times provided in this agreement shall give the Contractor the right to suspend work until payment is made, or at his option, after 30 days' notice in writing, should the Company continue to default, to terminate this contract and recover the price of all work done and materials provided and all damages sustained, and such failure to make payments at the times provided shall be a bar to any claim by the Company against the Contractor for delay in completion of the work.

Monthly Estimate.

36. So long as the work herein contracted for is prosecuted in accordance with the provisions of this contract, and with such progress as may be satisfactory to the Chief Engineer, the said Chief Engineer will, on or about the first day of each month, make an approximate estimate of the proportionate value of the work done and of material furnished or delivered upon the Company's property at the site of the work, up to and including the last day of the previous month. The amount of said estimate, after deducting .... per cent., and all previous payments, shall be due and payable to the Contractor at the office of the Treasurer of the Company on or about the 20th day of the current month.

Acceptance.

37. The work shall be inspected for acceptance by the Company promptly upon receipt of notice that the work is ready for such inspection.

Final Estimates.

38. Upon the completion and acceptance of the work the Chief Engineer shall execute a certificate over his signature that the whole work provided for in this agreement has been completed and accepted by him under the terms and conditions thereof, whereupon the entire balance found to be due to the Contractor, including said retained percentage, shall be paid to the Contractor at the office of the Treasurer of the Company within .... days after the date of said final certificate. Before the time of payment of said final estimate the Contractor shall submit evidence satisfactory to the Chief Engineer that all payrolls, materials, bills and outstanding indebtedness in connection with this work have been paid.

Discussion on Contract Forms.

W. G. Atwood (Committee Chairman): The statement of the committee covers about everything that they have to say. Thirty-five legal departments approved the form as it stands, except for the lien clause. That lien clause we changed as a result of their criticism.

V. K. Hendricks (St. L. & S. F.): I would like to ask, as a matter of information, how the blank space after "time being of the essence of this contract" in Form *A* is to be filled in.

Mr. Atwood: That is for qualification or specification and description that will fit in the different cases, and the blank is left to be used for any of those purposes.

Mr. Fritch: I believe it would be an improvement if "all the necessary transportation, except as hereinafter specified," would follow after equipment. Then it would be sure to cover everything—labor, material and equipment.

Mr. Atwood: The committee will accept that change.

Mr. Rose: I do not quite understand that permit arrangement in paragraph 4, Form *B*. I think in many cases it would be better for the company to get the permit than the contractor.

Mr. Fritch: This refers simply to temporary permits. Any permanent permit should be secured by the company.

Mr. Rose: I would like to know if it is possible to carry out this section 14, taking out insurance in the name of the company for property the company does not own and has not accepted? I think it would be necessary to assign that portion of the work that is covered by insurance to the company in order to collect the insurance.

Mr. Atwood: It is the opinion of the committee that structures erected or material furnished to the company on the right-of-way under this contract, which provides for certain definite payments, is the company's property when it is so erected and furnished. And that the contractor has a lien on it, but the material or structure is the property of the company.

L. C. Fritch: Referring to paragraph 26, one thing that has not been quite satisfactory to me is the arbitration clause, the chief engineer representing the railroad company alone being the judge of the disputes between the company and the contractor. I do not believe that that would be sustained in the courts.

Hunter McDonald: My experience with respect to the matter of arbitration clauses is that they are entirely useless. You can go into court and get your controversy settled by a judge in a much more expeditious manner and with much more fairness and with about the same expense that you can by arbitration.

C. A. Wilson (C. E.): I was retained in a case where there was a suit brought for damages by a contractor. The suit was a jury case. The attorneys for the railway contended that this was not a suit in damages; that by the contract the engineer had been constituted the arbitrator between the two parties, and he had rendered his decision as arbitrator, and that therefore it was an appeal case from the arbitration of the engineer.

C. P. Howard (I. C.): I have been in some law suits in which these questions have been brought up. I don't remember the courts having passed on it, but my recollection of comment of eminent attorneys on the subject is that the

decision of the chief engineer in authority as an arbitrator would stand, unless it could be clearly proven that he had acted from fraudulent motives or had clearly made a mistake.

Mr. Atwood: An appeal can be carried either to a court or to an arbitration board after the completion of the work by agreement; but we feel it is necessary that the chief engineer have this power during the progress of the work to see that it is carried on.

L. C. Fritch: I would like to have a blank left in the third line, paragraph 29, before "engineer," so that if any company wishes to have the extra work controlled entirely by the chief engineer, that might be inserted.

The President: The committee will accept that.

Robt. Ferriday (Big Four): I would recommend that the time of giving notice be left blank in paragraph 32. A little job of grading would not amount to anything, but if a man has a one million dollar building, ten days would be pretty short notice.

L. C. Fritch: It does not seem to me that the clause is quite consistent. In one place it refers to equipment and fixtures; in another place to men and teams.

Mr. Gifford: The word "Owned" might be changed to "equipment and fixtures owned by the contractor." Frequently the contractor rents the equipment. We might change the word owned or leave it out entirely and make it read, "The value of all fixtures and equipment furnished by the contractor on the work."

The President: The committee will accept that.

The President: The committee will insert a blank instead of the figures "10" in paragraph 33 under the title of annulment, to agree with the other cause.

Mr. Rose: I move that "20th" be left blank in paragraph 36.

The President: The committee accepts that.

Edward Gray, Jr. (C. & O.): It seems to me there might be some ambiguity in the last clause of paragraph 15 "Negligence in guarding the same," seems to exclude everything outside of it, as now written and punctuated. If that was intended it seems to me we would have to use "guarding" in a too general sense. I would suggest that it read "By reason of any act or omission of said contractor, or in consequence of any negligence or carelessness in guarding same."

Mr. Atwood: The committee will accept that.

Mr. Rose: This will not save the company from suits for patents. I do not think that is covered.

Mr. Atwood: That has been referred to the legal departments of several of the roads represented on the committee, and they have all ruled that it did cover patents.

Mr. Hendricks: I move that the last line of paragraph 1, reading "The final completion and acceptance of the work" be stricken out, and that it read "After the expiration of the time in which liens can be filed."

Mr. Atwood: The committee would suggest as a substitute for that, the words "Until the final completion or acceptance of the work" be struck out, and that it be replaced by blank, to be filled in as desired.

Mr. Hendricks: I will accept that.

Mr. Lloyd: Clause 36 says the materials shall be paid for. I do not understand why he should get additional compensation for the materials.

Mr. Atwood: Materials delivered prior to the first of the month during which the suspension might take place, would be paid for under the estimate. If we add the word "materials" in this clause it would cover interest on materials after that time and during suspension.

(The committee was discharged, their work having been completed.)

WOOD PRESERVATION.

The board of direction assigned the following subjects:

(1) Continue investigation of proper grouping of different timbers for antiseptic treatment.

(2) Investigate the merits of various preservatives, giving special attention to oil from water-gas tar, and to the use of refined coal-tar in creosote oil.

In addition to the subjects specifically assigned, the committee continued investigations on the following two subjects assigned in previous years, but on which no final report was made:

(3) The advisability of revising the specifications for fractionation of creosote oil.

(4) Recommend forms for the inspection of preservative processes.

GROUPING OF TIMBERS FOR ANTISEPTIC TREATMENT.

In the report last year the committee stated the fundamental principles governing the grouping of timbers for treatment, which were adopted by the association for publication in the manual. It was the consensus of opinion that further recommendations could not be made until an extensive series of experiments had been conducted, which would indicate the proper practice at stated locations, and with timber from specific regions. An outline of the points to be covered by experimental work in different regions was prepared and sent out to the members of the sub-committee on grouping, and some investigative work has been in progress during the year. However, owing to the long time required to reach definite conclusions and because of the difficulty of arranging for sustained experimental work along uniform lines, no data are available which would justify changing or adding to the fundamental principles outlined last year.

Some of the best authorities express the opinion that, owing to the variations in the character of the same kind of wood in different regions, the problems of grouping must be worked out at each individual treating plant, and that statements regarding detail practice which would have general application cannot be made. Another view of the matter, which has been expressed, is that the next step is to determine the laws governing the penetration of creosote, from which the grouping of timbers according to natural resistance may be made. As the committee has no facilities for studies of this kind,

EARL STIMSON,
Chairman Committee on Wood Preservation.

and since the wood-preserving industry looks to the U. S. Forest Products Laboratory and other institutions devoted to technical investigations for reports along this line, it is recommended that the attention of the United States Forest Products Laboratory be called to the desirability of a study of the regional variation in wood structure by species, in reference to the absorption of preservatives.

The committee will continue its investigations along these lines during the coming year.

THE MERITS OF PRESERVATIVES.

The Use of Refined Coal Tar in Creosote Oil.

The sub-committee to which this subject was assigned made an exhaustive research for facts pertaining thereto upon which the committee might base a report and definite recommendations. The result was such that the committee was not able to reach a conclusion and is not in position at this time to present a report with recommendations to the association. The committee, therefore, reports progress, and will continue the consideration of this subject.

The Use of Oil from Water-Gas Tar.

So far as the committee has been able to learn, water-gas creosote has not been extensively used under its own name as a wood preservative, and there is very little information to be found as to its efficacy. A few piles treated with it are driven in the harbor at Norfolk, Va. These waters are badly infested with Teredo, and the piles are said not to have been attacked, although they have been there about three years. Professor Alleman has a tie at Swarthmore which was treated

with water-gas creosote and was in service nine years at Porto Rico. This tie is still sound. The Public Service Corporation of New Jersey has been using water-gas creosote for several years for treating ties. These ties should show in about two years whether the treatment is good or not. They are now treating a large number of pine ties with straight water-gas creosote furnished by the United Gas Improvement Company of Philadelphia. One of the large creosoting companies has recently obtained a patent for treating wood with a mixture of water-gas creosote and coal-tar creosote, and one of the large railroad companies is contemplating the use of a mixture of water-gas creosote and coal-tar creosote for ties. The United States Forest Service has some specimens treated with water-gas creosote placed at West Pascagoula and Gulfport, Miss.; the latter put in the water in March, 1912. None of the specimens has been there long enough to give any results. It seems that the principal objection to water-gas creosote has been to its unauthorized use as an adulterant in coal-tar creosote. Its use, however, is now increasing in legitimate mixtures, and, while it is too early to get any results, it seems that a number of people favor using at least a mixture of this oil with coal-tar creosote.

It is recommended that the investigation of this subject be continued for another year.

CONSIDERATION OF THE SPECIFICATIONS FOR FRACTIONATION OF CREOSOTE OIL.

For some years past the committee has had under consideration the relative merits of the flask and retort for the fractionation of creosote oil. For the purpose of obtaining information on this point, and on which to base consideration of further revisions in the specifications for fractionation, the committee sent samples of various creosote oils to different railroads for fractionation by the various methods. Based on these examinations, the committee recommends that no change be made in the adopted specifications for fractionation of creosote oil.

FORMS FOR REPORTING INSPECTION.

Two forms for reporting inspection of treatment are submitted. Form "A" provides a record of the treatment and the determination of the absorption of the preservative by gage readings. Form "B" provides a record of the determination of the absorption by weighing. These forms are intended as a general guide for reporting and keeping records of the inspection of the treatment of timbers, and may be varied to suit any special kind of treatment.

The following is explanatory of the gage readings, designated by letter on Form "A":

Reading "A"—Is the reading of the measuring tank gage before the oil is put into the cylinder.

Reading "B"—Is the tank gage reading when the cylinder is completely filled.

Reading "C"—Is the tank gage reading when the pumping of the oil into the cylinder is stopped.

Reading "D"—Is the tank gage reading after all the oil from the charge is returned to the measuring tank.

Reading "A" minus "D," corrected for temperatures, gives the number of gallons used in the charge.

Reading "B" minus "C" gives the number of gallons pumped into the timber after the cylinder is filled and is used to give the gross absorption for light processes where oil is taken out of the timber by an initial air pressure, or by a final vacuum, or both. There will be a discrepancy in this gross absorption, due to the amount of oil absorbed by the timber while cylinder is being filled.

RECORDS FROM SERVICE TESTS.

In Appendix "B" to this report was given the record from service tests, brought up to date and extended to include a number of additional tests not shown on the records submitted with the report of last year.

CONCLUSIONS.

It is recommended:

(1) That no change be made in the adopted Specifications for the Fractionation of Creosote Oil.

(2) That the forms "A" and "B" for reporting the Inspection of Treatment of Timbers, and the notes explanatory of the gage readings on Form "A," as given under the subhead "Forms for Reporting Inspection," be adopted for insertion in the manual.

OUTLINE OF WORK FOR 1913.

The committee recommends:

(1) Continue investigations of the merits as a preservative of oil from water-gas and the use of refined coal-tar in creosote oil.

(2) Continue the compilation of available information from service tests.

(3) Continue the investigation of the proper grouping of the different timbers for antiseptic treatment.

(4) Report on methods of accurately determining the absorption of creosote oil.

(5) That the board of direction assign the work of drawing up a standard specification for timber for treatment to a joint committee of the committee on wood preservation and the committee on grading of lumber.

Earl Stimson, chairman (B. & O.), E. H. Bowser, vice-chairman (I. C.), G. M. Davidson (C. & N.-W.), H. B. Dick (B. & O. S. W.), C. F. Ford (C. R. I. & P.), Dr. W. K. Hatt (Purdue Univ.), V. K. Hendricks (S. & L. & S. F.), George E. Rex (A. T. & S. F.), E. A. Sterling (Cons. Engr.), C. M. Taylor (P. & R.), Dr. H. von Schrenk (Cons. Engr.), T. G. Townsend (Southern), Committee.

Discussion on Wood Preservation.

Earl Stimson, Committee Chairman: Under the heading "Consideration of the specifications" for fractionation of creosote oil," I will ask Dr. Von Schrenk to present the subject.

Dr. H. von Schrenk: The experiments to which the chairman refers were made as a result of a number of inquiries which came to the committee last year, as to whether the standard practice now printed in the Manual for fractionating coal-tar creosote was the best method for conducting this operation, and in order to secure fuller data on the subject, two separate creosoted oils were sent out, by the sub-committee to a number of railroads, with the request that they analyze or fractionize these samples according to the standard methods now printed in the Manual, and according to a suggested method of using a flask instead of a retort which had been presented by a sub-committee of this committee two years ago. The oils were labeled respectively A and B. The samples all come from the same cans, and the methods prescribed by the Manual and by the recommendation made to the committee two years ago were followed by various operators for various companies. The results have been tabulated in the report this year. A careful study was made. First as to the variations in results between the two methods per se and then a study of the variations due to the fact that different individuals were using one and the same method. After a careful tabulation of these variations, the committee came to the conclusion that the present method as printed in the Manual, showed a variation which was slightly less from the personal standard than that obtained in the fractions made with the suggested method, and we could find no evidence of any improvement which could be obtained by the suggested method, over the one which we have standing in the Manual at the present time, and in order that these results might once and for all be available to those interested in the subject, we have presented in full the actual results submitted by the individual operators.

Mr. Stimson: I will say in explanation of Form "A" that it provides a record of the treatment and the determination of the absorption by gage readings. Form "B" provides a record for the determination of the absorption by weighing. Form "B" provides a check against Form "A." I move that this be adopted for insertion in the Manual. (The motion was seconded and carried.)

TIES.

The board of direction assigned the following subjects to the committee:

(1) Report on the effect of design of tie-plates and track spikes on durability of ties.

(2) Continue study of the stresses to which cross-ties are subjected, and determine size required.

(3) Report on economy in labor and material effected through use of treated ties compared with untreated ties.

(4) Continue the compilation of information as to the use of metal, composite and concrete ties.

The report on the effect of the design of tie-plates and spikes on the durability of ties is given in appendix A, and is submitted as information.

The report on the subject of stresses to which cross-ties are subjected is given in appendix B.

The committee also reports progress on the subject of economy in labor and material effected through use of treated ties compared with untreated ties.

In appendix C was given a compilation as to the use of metal, composite and concrete ties.

CONCLUSIONS.

The committee has given the subject of stresses to which cross-ties are subjected an exhaustive study, covering a period of two years, and after conferences with a number of leading members of the Association, finds no reason to change its conclusions submitted in 1912, and given on page 331 of Volume 13, and resubmits them for adoption:

The conclusions of the committee are as follows:

(1) It is impracticable to perform experiments to determine size of cross-ties, for the following reasons:

The character of the subgrade varies radically on the same road and in different parts of the country. The kind of ballast varies widely. The necessary depth of ballast varies with the weight of axle loads as well as density of traffic. The necessary distance between face of ties varies with the weight of axle load, as well the density of traffic. The kinds of timber used for ties vary in different sections of the country. The width of base of rail (or weight of rail) and use of tie-plates. Treated or untreated ties, crushing stress and durability. Amount of labor spent on track maintenance and drainage.

(2) It is recommended that the report on the effect of design of tie-plates and track spikes on durability of ties be received as information.

(3) It is recommended that the report on metal, composite and concrete ties be received as information.

L. A. Downs (I. C.), Chairman; G. W. Merrell (H. & W.), Vice-Chairman; H. W. Brown (Pa. Lines), W. J. Burtin (M. P.), L. C. Hartley (C. & E. I.), E. D. Jackson (B. & O.), H. C. Landon (Watauga R. R.), F. R. Layng (B. & D. E.), E. R. Lewis (D. SS. & A.), R. J. Parker (A. T. & S. F.), L. M. Perkins (H. P.), J. G. Shillinger (Rutland), G. D. Swingly (B. & O.), D. W. Thrower (I. C.), H. S. Wilgus (P. S. & H.), Louis Yager (M. P.), E. C. Young (N. Y., P. & H.), Committee.

L. A. DOWNS,
Chairman Committee on Ties.

APPENDIX A.

The Effect of the Design of Tie-Plates and Spikes on the Durability of Ties.

A circular letter requesting information relative to this subject was sent to members of the Association. The following is a list of the questions asked:

(1) Do you use flat, longitudinal flange, transverse flange, pronged or corrugated tie-plates?

(2) Please send plan of your standard tie-plate, and give method of applying.

(3) Do you use screw or cut spikes?

(4) In your opinion, how far should tie-plate extend outside base of rail to overcome side thrust, and what should be total bearing area? Give reasons for your conclusions.

Replies were received from 61 railroads. The number of roads using only one design of tie-plate and the kind of plate used, are:

Longitudinal flange	16
Transverse flange	8
Flat	5
Pronged	4
Corrugated	11

The number of roads using two designs of tie-plates and kind of plates used, are:

Longitudinal flange and flat	3
Longitudinal flange and pronged	1
Longitudinal flange and corrugated	1
Transverse flange and pronged	1
Transverse flange and corrurgated	1
Flat and pronged	1
Pronged and corrugated	1

The number of roads using three designs of tie-plates and kind of plates used, are

Longitudinal flange, transverse and flat	1
Longitudinal flange, transverse and corrugated	2
Longitudinal flange, flat and corrugated	1
Longitudinal flange, pronged and corrugated	1
Transverse flange, flat and pronged	1

The number of roads using four designs of tie-plates and kind of plates used, are:

Longitudinal flange, transverse, pronged and corrugated	1

The committee was unable to obtain any definite information bearing on the relative effect of the different designs of tie-plates and spikes on the life of ties, but it is thought that experiments, which are now being conducted, will throw some light on this subject in the near future.

APPENDIX C.

Study of the Stresses to Which Cross-Ties are Subjected.

The assigned topic resolves itself into two parts:

Continue the study of the stresses to which cross-ties are subjected, and determine the size required.

In order to have an expression of opinion as to the best method for handling the topic, a letter was sent to 27 members of the Association and 15 replies were received which show quite a divergence of opinion. "Track Deformation," by Cuenot, covers very well many of the suggested methods mentioned in said letters for solving the second half of the topic.

The first part of the assigned topic may be touched upon to the extent of spacing of the ties. The preponderance of the mileage voting is in favor of twelve-inch face to face; the next in favor is ten-inch; the next thirteen-inch. The recommendation of this committee for 1912 was ten to twelve-inch, and the above table substantiates its recommendation.

The Ballast committee published a translation of "Gravel as Ballast," by C. Bräuning in the proceedings for 1912, Vol. 13. Mr. Bräuning's conclusions, which are in accord with the committee's recommendations, are as follows:

"Of greater importance than the width of the tie is the spacing of the ties. As the spacing is decreased two advantages are derived: first, the unit pressure is decreased; secondly, the carrying capacity of the roadbed is increased. It is just within the limits of tie spacing usually considered that the relation a-b (a = distance face to face to tie; b = depth of tie) ranging from 3½ to 2 (spacing 35-inch and 19½-inch center to center) that the carrying capacity increases at a high rate. The limiting feature of decreasing tie spacing is the ability to tamp the ties properly. Ties 6½ in. in height can still be tamped with convenience when separated 13½ in. But this 23-inch from center to center is the lowest limit. This is the one most effective and simplest means of increasing the strength of the roadbed and to utilize it to the fullest advantage, especially on roadbeds which are fully loaded, is urgently recommended."

Mr. Byers, Vol. 1, 1911, International Railway Association, says "20-inch center to center of ties small as practicable." With an 8-inch tie the spacing face to face is 12 in. Therefore the committee feels that its conclusions are fully in line with Mr. Bräuning's recommendations, though prepared without knowledge of either Messrs. Bräuning's or Byers' conclusions.

TABLE 1.

Spacing Face to Face, Inches.	Recommending. Name of Company	Mileage of Each Railroad.	Mileage for Each Spacing.	Percentage.
6	American Creosoting Co.	.....	.....	..
7	N. Y. C.—G. W. Kittredge	.....	2,829	5
8	C. & E. I.	.....	966	2
10	B. & A.	628	.....	..
10	G. T.—Burton & Allrug	4,757	.....	..
10	I. C.	2,245	.....	..
10	K. & M.	175	.....	..
10	N. & W. (G. W. Merrell—See 11")	1,951	.....	..
10	P. & R. (F. S. Stevens—See 13")	1,509	.....	..
10	P. & L. E. (J. A. Atwood—See 12")	215	11,480	20
11	E. P. & S. W.	902	.....	..

11	N. & W. (C. S. Churchill—See 10")	1,951	.....	..
11	Q. M. & S.	192	3,045	5
12	C., B. & Q.	8,966	.....	..
12	A., T. & S. F.	10,208	.....	..
12	C., R. I. & P. (J. M. Brown—See 13")	8,020	.....	..
12	P. & L. E. (E. F. Wendt—See 10")	215	.....	..
12	W. P. T.	64	27,473	47
13	C., R. I. & P. (Garrett Davis—See 12")	8,020	.....	..
13	P. & R. (R. B. Abbott—See 10")	1,509	9,529	16
13½	L. V. (as a maximum)	.....	1,432	2
15	W. M.	.....	543	1
10 to 12	L. S. & M. S.	.....	1,663	2
			58,960	100
	Total mileage of Association.	.....	261,000	..
	Percentage here represented, 23.			

Vol. 13, pp. 306 and 307 of the Proceedings for 1912 give a table of the different number of ties per 30-ft. rail, the percentage of roads using 6 x 8 x 8 and a table giving the different sizes of cross-ties in current use. The divergence of practice is undoubtedly largely due to varying conditions in different localities and to a tendency to "follow the leader." The latter is probably nearer the mark, as the tendency in American railroading has been in the past, and only now is being broken away from, for the railroad heads always to compare the engineering department recommendations with practice on other roads, with the result that in many lines our progress has been slow.

Report was received as information without discussion.

SIGNS, FENCES AND CROSSINGS.

The following subjects were assigned for consideration:

(1) Report on the relative advantages of the different kinds of fence posts, with definite recommendations.

C. H. STEIN,
Chairman Committee on Signs, Fences and Crossings.

(2) Report on the best form of track construction and flangeways at paved street crossings and in paved streets, with definite recommendations.

(3) Continue the investigation of ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.

RELATIVE ADVANTAGES OF THE DIFFERENT KINDS OF FENCE POSTS.

Replies were received from 44 railroads, with the following information as to kind of post used, cost, life of same, etc.:

It will be observed from the foregoing that the various roads use the different kinds of timber indigenous to their geographical position as follows:

Cedar	32	Oregon Fir	1
Chestnut	7	Juniper	1
Locust	9	Tamarack	1
Oak	9	Burnettized Pine	1
Bois D'Arc	5	Mulberry	1
Catalpa	1		

There are certain species of each of the above woods that are not suitable for fence posts, but doubtless must be used because they are cheap and native to the locality. This is indicated by the following summary:

Life of Posts.

Red Cedar	7 to 25 years	Black Locust	10 to 25 years
Cedar	10 " 30 "	White Oak	7 " 15 "
White Cedar	12 " 17 "	Bois D'Arc	12 " 45 "
Chestnut	10 " 15 "	Catalpa	10 " 25 "
Locust	7 " 20 "	Juniper	15 "
Yellow Locust	15 " 30 "	Mulberry	15 " 20 "

Doubtless some give little heed to the particular species of such timber that they use, and assume that any species of that genus has about the same life. This is manifestly incorrect, as is demonstrated by the oak family. The inferior grades of oak have only a life of from two to four years, while a good white oak has a life in our northern climates of from 10 to 12 years at least. Certain classes of oak last much longer in their native regions than in other localities to which they are transported for use. This principle applies with equal force to every other class of timber.

In reviewing the replies of the various roads, we find that the consensus of opinion, based upon the experience of the users, is that the different classes of timber have an average life as indicated below:

Red Cedar	18 years	White Oak	10 years
White Cedar	15 "	Bois D'Arc	25 "
Chestnut	12 "	Catalpa	15 "
Yellow Locust	20 "	Juniper	15 "
Black Locust	20 "	Mulberry	15 "

Climatic influences have an important bearing upon this phase of the case, and may lengthen or shorten the life of a particular kind of wood, dependent upon locality in which used. It is not feasible in most cases to recommend any particular kind of timber for a given territory, as the source of supply may be so distant as to preclude its use economically. According to information received, the cost of the various kinds of wood posts is:

	Range.	Average.
Red Cedar	15c to 25c	22c
Cedar	7c " 20c	14c
White Cedar	12c " 15c	14c
Chestnut	10c " 27c	20c
Locust	15c " 40c	25c
Yellow Locust	20c " 38c	30c
Black Locust	15c " 25c	20c
White Oak	11c " 40c	20c
Bois D'Arc	13c " 17c	15c
Catalpa	15c " 25c	20c
Juniper	6c " 10c	8c
Mulberry	13c " 17c	15c

It will be observed that the relative cost to life of post ranges from one-half cent to two cents per year of life, the Bois D'Arc and the Juniper being the cheapest posts, but so rare that a more general use is impossible.

It was of interest to know to what extent wooden posts were subject to destruction by fire. Replies received indicated that this varied by from 1 per cent. to 5 per cent., with the exception of one road which reported a loss of 30 per cent. from this cause. We think it fair to assume that the average loss by fire is around 3 per cent.

Only two roads so far as we can learn make mention of having used any metal posts, and then only to a limited extent. In the one case bar iron ¼ in. x 2 in. was used, and in the other, old boiler tubes. We have reason to believe, however, that quite a number of roads, not replying to our circular, are trying out a proprietary metal post. Several styles of steel right-of-way fence posts are on the market. Their exploitation has just begun in the last year or two, and any statement as to their efficiency and economy could be but vague and from the manufacturers' standpoint alone. Greater experience may demonstrate their utility, but thus far we have no data upon them, and can only give some computations from one of the manufacturers, which might be of interest for study from the viewpoint of railroad economy. These figures, while prepared for a certain style of post only, if reliable, will no doubt be equally accurate for any other style of metal post, built along similar lines, and others are generally so designed. In order that the membership may have the manufacturers' explanation of the merits of the steel post for their further consideration, we give the statement of the case in substance according to one with whom we have had the matter under discussion:

Steel posts cost	23.03 cents
Cost of setting	1.30 "
Total	24.33 "
Estimated life	30 years

Based upon above figures, steel posts set one rod apart cost .81 cent per year.

The cost of setting wood posts is estimated at 5.8 cents each. The following table is based on wood posts costing from nothing up to 20 cents each, and is intended to show what the life of wooden posts must be at different first costs to be as cheap as the steel post:

Cost of post.	Cost of setting.	Total cost.	Years it must last to be as cheap as steel.
0 cents	5.8 cents	5.8 cents	7.1 years
5 "	5.8 "	10.8 "	13.3 "
8 "	5.8 "	13.8 "	17. "
10 "	5.8 "	15.8 "	19.5 "
12 "	5.8 "	17.8 "	21.9 "
15 "	5.8 "	20.8 "	25.6 "
17 "	5.8 "	22.8 "	28.1 "
18.53"	5.8 "	24.33 "	30. "
20 "	5.8 "	25.8 "	31.2 "

The above figures would indicate that wood posts costing 15 cents would have to have a life of 35.6 years and those costing 20 cents a life of 31.8 years to be as cheap as steel.

The first steel posts are said to have been manufactured about fifteen years ago at Bloomfield, Ind. Others, doubtless, of different design unknown to the committee were manufactured as long ago and perhaps longer, but only during the past 12 years have they been given any serious study with a view to placing them on the market for ordinary right-of-way fencing. Hundreds were taken up and examined to discover signs of rust, and deterioration at the ground line or elsewhere. They have been in use at Spencer, Worthington, Bloomfield, Ind., and elsewhere in all kinds of soil and under all conditions. The investigations have resulted in placing them on the market during the past year or so.

To be of economic worth for right-of-way protection, a fence post must possess the following qualities: durability, practicability, efficiency, and the price must be right. Inquiry develops that one man can set in a day from 15 to 35 wooden line posts. To be conservative, 30 posts per day per man is assumed as the unit of work. Estimating wages at $1.75 per day places the cost of setting a wood post at 5.8 cents. The cost of post is estimated at 12 cents, resulting in an entire outlay of 17.8 cents. Experience is said to have demonstrated that three men can readily set from 390 to 640 steel posts per day, or 130 to 213 per man—130 posts per man is taken as the basis of calculation with wages at $1.75 per day. This places the cost for setting a steel post at 1.3 cents. Cost of steel post 23.03 cents, plus cost of setting 1.3 cents, resulting in entire outlay, 24.33 cents.

Comparative Cost of Steel and Wood.

Entire cost of steel post 24.33c; estimated life 30 years.
Money worth 6 per cent.
Entire cost of wood post 17.80c; estimated life 12 years.
Expenditure for steel posts..................24.33 cents
Expenditure for wood posts..................17.80 "

Difference .... 6.26 "

Compound interest on 6.26 cents for 12 years amounts to 13.06 cents. At the expiration of 12 years wood posts have failed and need renewal. 13.06 cents has been saved over cost of steel posts. This is equivalent to purchasing 8.8 years more protection with wood. In other words, 24.33 cents expended for steel give 30 years of protection, while same amount expended for wood gives 12 years original life, plus 8.8 years interest on investment, or 20.8 years, a balance in favor of steel of 9.2 years. Viewing the matter from another angle, assuming that posts are set one rod apart, track protection costs per year as follows:

Steel Posts.		Wood Posts.	
Per rod	$ .0081	Per rod	$ .0117
Per mile	2.59	Per mile	3.74
Per 100 miles	259.00	Per 100 miles	374.00

Balance in favor of steel posts of
$ .0036 per rod per year.
1.15 per mile per year.
115.00 per 100 miles per year.

Other advantages claimed are no staples used; right-of-way may be burned over from time to time without injury to posts. No loss from accidental fires and no renewal on that account. Special end, corner and gate posts must be used in connection with the steel line post. No means are provided for bracing them so as to use them as end or corner posts. There is not enough steel in them to stand the strain of stretching a heavy wire fence. The minimum amount of steel necessary is used to meet the requirements of a right-of-way fence. The line and end posts are treated as distinct problems. In this they are not unlike posts made of other materials.

Comparative Cost of Steel and Wood End and Corner Posts.
Cost of End Post......................................$1.62
Cost of Corner Post.................................. 2.30

Assuming it fair to say that twice as many end posts will be needed as corner posts, it places the average of the stretching post at $1.84 each. If $1.84, the cost of the steel corner post, bears the same relation to the cost of a good wooden corner post that the price of the steel line post bears to the price of the wooden post, then the economy is demonstrated. In order to determine whether or not this relation maintains, we resort to the following equation:

$$\frac{\text{12c (cost of wood line post)}}{\text{23.03c (cost of steel line post)}} = \frac{\times \text{ (cost of wood corner post)}}{\text{\$1.84 (cost of steel corner post)}}$$

We find $\times = 96$ cents, cost of wooden corner post, which appears to be a conservative estimate of the cost of a good wooden corner post. From a mathematical and perspective point of view, the manufacturer of the steel fence post appears to have made out a case that is worthy of continued and further close investigation. Time alone, under practical service conditions, can demonstrate if the figures are based upon substantial premises, and subject to corroboration. To be efficient and adequate, the steel posts must resist corrosion, must be sufficiently strong to withstand ordinary and accidental hard usage, must not heave from the ground in winter, must remain firm and not loosen up, permitting the fence to get out of proper alignment. The speedy extinction of our forest lands and the failure on the part of all concerned to encourage the practice of reforestation, caused the users of wooden fence posts to seek some efficient substitute. The steel fence post has not yet proved its merit in practice and at this time concrete with suitable reinforcement seems to offer the only solution to the problem.

It is recognized as a primary proposition in the design of a concrete fence post that in order to secure a post of such weight that it can be readily handled, it must not be too heavy; hence, reinforcement is necessary to reduce the bulk of concrete. This reinforcement must bear a co-ordinate relation to the concrete and act in harmong with it. To produce this result it must be properly placed, and make a proper mechanical bond with it. It has been demonstrated that while concrete posts are not as strong as wooden ones, they are sufficiently strong to meet all practical conditions.

The committee has gotten into touch with the various manufacturers of concrete fence posts, as well as with the various railroads that are experimenting with them, so far as has been possible, and will endeavor to present some data relating to them. Not more than a dozen railroads are using concrete posts in large quantities at this time, but a large number are pursuing the subject with a view to their extensive use.

In reviewing the methods employed by the various manufacturers and railroad companies who have given this subject careful investigation, we find that they accord very closely with practices recommended by the United States Department of Agriculture in Bulletin 403, and we, therefore, present certain extracts from that bulletin with some additional notes.

On account of the variations in the size of the sand grains and in the unfilled spaces between the particles of sand, stone and gravel, the quantities of concrete made, according to certain proportions may vary. For the same reasons the quantity of water may or may not be sufficient to make the concrete wet enough. Water should always be measured by the bucket to have uniform results.

Different pockets of sand and gravel and different crusher-run rock vary in size and consequently in the unfilled spaces or voids between the grains or pieces. If unscreened bank run gravel is decided upon, it should be used in the proportion of one part of cement to four parts of gravel. For crushed rock or screened gravel (which is much better than bank run gravel) the concrete should be used in the proportion of one part of cement, two parts sand and four parts of rock or gravel. Also one part cement to four parts chats makes good concrete. All measurements should be made with the material poured loosely into the measuring box and the box when full should be leveled smooth.

The amount of moisture in sand, gravel and stone varies so much with weather conditions that the quantity of water for a cubic foot of concrete cannot be fixed exactly. During the mixing of the cement with the sand and rock sufficient water should be used for the concrete to be wet enough when the mixing is complete to tremble under a blow from the shovel. This amount of water causes a rich mortar to flow to the outside of the post and insures a smooth finish.

In general, where crushed rock or screened gravel is used, the full amount of sand is spread out upon the board and

upon it the necessary cement is evenly distributed. The whole is turned dry until the cement no longer shows in streaks, and the color of the batch is uniform. The mixture is then spread out flat, just as the sand was, and upon it the crushed rock or screened gravel is distributed evenly. Three-fourths of the water required is added and the mixing is continued. In dry, hot weather it is a good plan to throw water on the pile of crushed rock before mixing.

Concrete has a tendency to stick to either steel or wood. In order to yield a smooth finish to the post, it is customary to give the inside of the molds a coating of oil. Soft soap or crude oils used sparingly serve the purpose well. Too much oil will destroy the setting qualities of the cement and will give a face roughened with pockmarks. A small amount of oil, poured into a pail of water and applied with a mop or stiff broom in scrubbing out the molds after they have been used five or ten times, or as often as necessary, will prevent the concrete from sticking.

After the molds, which, as a rule, lie flat, have been oiled or soaked, the concrete should be placed in them at once. If for any reason the concrete stands thirty minutes after mixing, it should be thrown away and a new batch mixed, for cement, if it has once partially set, makes weak, dangerous concrete, even though it is retempered by turning or adding water. If wooden molds are used, they should be well soaked in water so that the concrete post will not cause them to swell and thus crack the post.

Reinforcing should be placed near the outside wall, where it is reasonable to expect that cracks will open. For reinforcement, metal slightly rusted is as good if not better than metal that is not rusted. In placing the reinforcing rods in position it is a wise precaution to bend them back at the ends. This takes only a little more time, but, if it is done, the reinforcement must be two in. longer to allow the metal to be turned back one in. at each end of the post. New barbed wire should not be purchased for reinforcement, for while it costs more than plain reinforcement, the bond between it and the concrete is no stronger than between smooth wire and concrete. The danger section, or the point where posts are liable to break, is at the surface of the ground. For fences for lots and other places where posts may be subject to rubbing and crowding, short extra reinforcing pieces two ft. long are sometimes placed in the post to lap this danger section.

It is a great mistake to believe that, when the molding is done, a concrete post is finished. The quality of the post must be determined by curing. The green post should be left in the mold until thoroughly hardened; usually for two or three days. During the first two days of the life of a post it must be kept wet and covered with canvas, burlap, carpet, or any clean material. Sand will serve after the concrete has become hard, but manure will stain green concrete and otherwise affect it. The sprinkling should be continued up to the eighth day. After the tenth day, if the space is needed, the post may, with care, be placed on end in the same manner that wooden fence rails were formerly piled. A drop of only 6 in. often breaks a green post. The jar in hauling to the field over rough, frozen roads or in a wagon bed with a very uneven bottom has seriously injured posts which were not well seasoned. Concrete posts gain rapidly in strength for the period of one year; they should, therefore, be made as long as possible before it is necessary to set them in the fence. No post should be used until it is at least 3 months old, and, to meet any contingency, a supply of well-seasoned posts should be kept on hand.

There are numerous methods of attaching wire fencing to concrete posts. Some makers place staples or wire loops in the green concrete; others make holes in the posts. The former method is not desirable, because the fastener cannot be located exactly where the wire of the fencing will come when the post is set in the ground; then, too, the fastener will eventually rust or break off and will thus injure the looks of the post. On the other hand, holes through the posts weaken them and therefore this method is, in general, unsatisfactory.

The simplest, easiest and cheapest way of fastening a wire fence to a concrete post is to encircle the post with a wire one size less than the corresponding wire in the fence proper, and to twist this wire around the strand of the fence. This is done in two ways. The fastening wire is placed around the post, twisted upon itself and then to the fence wire; or one end of the fastening wire is twisted around the fence wire, and the free end is then carried around the post and twisted on the other side to the same wire. Either plan is good, but care must be taken to draw the fastening wire tight, or else stock trying to get through the fence may raise or crush down the fencing with their heads. If any trouble is experienced, the post should be roughened at the fastening point with a cold chisel.

Expansion and contraction of the fence, due to heat and cold, are cared for by the tension curves of "kinks" in the woven wire fencing, and no fear may be felt in drawing the fastening wires as tight as necessary. Wooden nailing strips should never be embedded in the posts, for moisture will swell the wood and crack the concrete.

In the early stages of concrete post making it was the opinion of some that posts need not be tapered from base to top, but it has now become the almost unanimous judgment that taper is necessary for many good and essential reasons. It has been definitely demonstrated that it almost entirely if not absolutely prevents heaving in winter. A fence post acts as a cantilever and the post is therefore largest toward the ground line, where it is the most severely stressed. It also reduces the amount of concrete required, lessening the quantity toward the top of the post, where the full section, as at the base, is not required. The tapered post lends itself most naturally to the fastening of the fencing wire by means of the loop around the post, the taper preventing displacement of the loop.

Conclusions.

(1) Concrete posts are practical, economical and a suitable substitute for wood.

(2) Reinforcement should be placed as near to surface of post as possible; ½ in. from surface is best location.

(3) Post should taper from base to top.

(4) Post should not be less than 5½ in. at base and 4 in. at top.

(5) Concrete mixture should consist of one part cement to four of run of pit gravel; or one part cement, two parts sand and four parts crushed rock or screened gravel. Gravel or crushed rock not to be smaller than ¼ in. in size, nor larger than ½ in. Concrete should be of a quaking consistency.

(6) Molds should have a jogger or vibratory motion while the concrete is being introduced to compact it and smooth up the surface of post.

(7) Posts should not be made out of doors in the freezing weather. They should not be exposed to sun, and should be sprinkled with water the first eight or ten days after being made to aid curing.

(8) Molds should be carefully oiled or soaped to provide a smooth finish and to prevent concrete sticking to mold.

(9) Posts should be cured for not less than 90 days before being set or shipped.

(10) Posts should be carefully handled and be packed in straw, sawdust or other suitable material for shipment.

Recommendations.

(1) We recommend the adoption of conclusions 1 to 10 relative to concrete fence posts.

(2) We recommend that the foregoing conclusions be substituted for those in the 1911 manual, page 210, upon the subject of concrete fence posts.

We recommend to the board of direction that the committee be directed to endeavor to have a series of tests conducted to determine the comparative strengths of the different forms of concrete fence posts and method of reinforcing, with a view to ascertaining the most suitable form, these tests to be performed, if possible, at one or more of the university or government laboratories.

TRACK CONSTRUCTION AND FLANGEWAYS AT PAVED STREET CROSSINGS AND IN PAVED STREETS.

This subject has been under consideration for several years past, and the committee has studied the practice in European countries as well as our own.

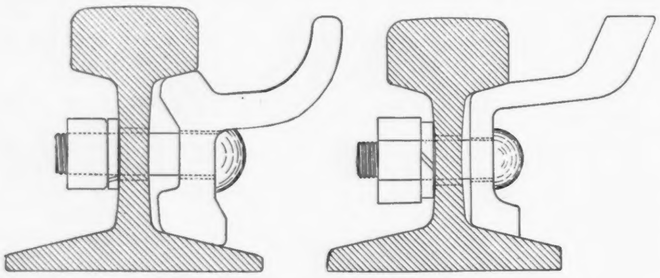
In both this and foreign countries, asphalt, bitulithic, wood block, brick, granite and trap rock paving have been tried. It has been exceedingly difficult to keep the paving along the rails in good condition where asphalt, asphalt blocks or bitulithic was used. In most cases where tried, these materials were removed from between the tracks, and for a distance of 2 ft. outside of rails, and replaced with wood or stone blocks. This has not only resulted in economy, but has also reduced the long interruptions to traffic due to the frequent repairs. The substance of our investigations would seem to indicate that granite or trap rock specification blocks make the most suitable material for this purpose.

It seems from plans sent us to have been accepted, as a matter of fact, beyond the pale of argument, by most of the steam and street railway lines, that a concrete bed of thickness varying from 4 in. to 12 in. is the proper form of construction for the track substructure. The committee, however, believes that this is not conclusive and that it is still open to question, particularly in the case of steam roads with extremely heavy cars and heavy axle loads of motive power, whether a concrete base will not have a train of evils

to follow in its course, even more serious than those to be met with in using a foundation of hard rock ballast, or other suitable material, with proper drainage provisions.

In a consideration of the various types of construction thus far tried, it is thought that the same design should be used at paved street crossings as through paved streets. The 141-lb., 9-in. girder rail appears to meet the general conditions of each case in the most satisfactory manner. It will not permit of widening gage on curves, however. Ordinary tee rails (on chairs of various designs if necessary to obtain depth for paving), have been used; a special rolled form of flangeway or an old rail laid on its side for flangeway opening is frequently employed, usually the latter, but this cannot be considered as the best form of construction.

In previous committee reports upon the subject of the best form of flangeway, the idea of a special rolled filler to provide flangeway opening has been referred to. This feature has been given some study and we find two or three roads using such an arrangment. It is our opinion that such a form of flangeway is suited to road crossing construction



Rolled Flangeway for Paved Streets.

where paving is not required, but is not well adapted to street crossings where rigid laws are in effect in regard to paving requirements, or through paved streets. The steel companies can roll these special forms, but they are very expensive because of the little tonnage that would be used. They are not mill stock, because a different section is needed for each weight of rail, and because of frequent changes in rail section.

The 9-in. girder rail can be very readily compromised to the ordinary tee rail with which the track is generally laid on each side of the crossing or at the end of the paved street. It is not the intention of the committee to state that there are not other styles of construction that will give, or do give, good results; nor is it of the opinion that a more permanent form will not be devised in the future, but it believes that for the amount of money expended that the design submitted already tried out under heavy service will be best adapted to meet the most general requirements from the standpoint of durability, high standard and economy of maintenance.

Conclusions.

(1) Specifications for best form of track construction and flangeways at paved street crossings and in paved streets:

Treated ties should be used, laid on a bed of crushed rock gravel or other suitable material, not less than 8 in. nor more than 12 in. in depth, placed in about 3-in. layers, each to be thoroughly rammed to compact it.

Vitrified tile drains not less than 6 in. in diameter, with open joints, leading to the nearest point from which efficient drainage may be obtained, or with sufficient outlets to reach sewers or drainage basins, should be laid on either side of and between tracks, parallel with the ballast line and outside of ties.

One hundred and forty-one-lb., nine-in. depth girder rail, or similar section, with suitable tie plates and screw spikes should be used. Track should be filled in with crushed rock, gravel or other suitable material, allowing for a 2-in. cushion of sand under finished pavement.

The ballast should be thoroughly rammed as it is installed for paving foundation to settle it. Two-in. of good sharp sand should be placed on top of the ballast.

Paving must conform with municipal requirements, granite or trap rock blocks preferred. Hot tar and gravel should be poured into the joints as a binder.

(2) The inclusion in the Manual of the plan for flangeway.

Recommendations.

We recommend the adoption of conclusions 1 and 2, Specifications and Plan of Best Form of Track Construction and Flangeways at Paved Street Crossings and in Paved Streets.

WAYS AND MEANS FOR SECURING A PROPER QUALITY OF FENCE WIRE TO RESIST CORROSION AND SECURE DURABILITY.

The committee has been continuing its investigations into this subject during the past year and has endeavored to obtain all available information as to the most recent practice, but it is compelled to state that the developments have been very few.

It is the opinion of one of the large manufacturers that the most practical solution of the problem of securing greater durability is by what is known as the "special galvanizing" process. The fence is made from wiped wire which will withstand four one-minute immersions in the standard copper sulphate solution for both the horizontals and stays. It is claimed that such a wire should compare favorably with unwiped wire, which will pass the same test. The committee thinks, however, that this is open to question, although we understand that large tonnages of this special galvanized wire is being supplied according to specifications of foreign railway companies.

We believe that the method of weaving the wire is one of supreme importance and that the brutal treatment that the wire receives during the course of weaving at some plants might be responsible for the quick deterioration of the wire. So far no satisfactory method has been devised of galvanizing the fence fabric after it has been woven, although many attempts have been made, but the expense appears thus far to be practically prohibitive from a commercial standpoint.

It is open to doubt in our minds whether the asbestos process of wiping the wire is as productive of good results as that of the old form of charcoal wiping. The asbestos wipers cannot at all times be adjusted with care and accuracy, so that one strand may carry a fair coating, while another will be wiped so closely as to almost entirely denude the steel.

In taking the matter of fence fabrication up with an expert in wire making, he stated that there were two accepted methods of fabricating the wire fencing. The ordinary and most generally used is the custom of selecting a very soft wire as the cross wire, first winding it on a bobbin so that it can be handled properly in wrapping it about the line wire of the fence. This process is extremely hard on the galvanizing, and there is practically no wire that will stand the treatment without showing material injury to the coating. A modification of this practice is to feed the cross wire in short lengths, and where the ends of the sections pass one another at the crossing of the line wire of the fencing, they are seized by a twister and wound together about the lateral strand.

The other method is that of applying a straight single piece cross bar the full width of the fabric and attaching it to the line wires by a separate and distinct section of wire known as a tie. This process undoubtedly results in the least injury to the wire used in the fabric, although it is impossible to get away from the wrapping of the ends about the selvage wires when using the straight stiff stay.

There is another process of electric welding, but it is an open question whether this does not change the structure of the steel and destroy the coating at the point of contact.

The committee is not prepared at this time to offer any additional information on this subject, nor is it warranted in reaching any conclusions. It believes that it is incumbent upon the railroad companies, in the light of past experience and with the information that has been imparted from time to time by the Association, to pursue their own investigations, and that investigation of this subject by the Association should be discontinued for the present.

Recommendations.

(1) We recommend to the Board of Direction the discontinuance for the present of the instructions to investigate ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.

(2) We recommend to the Board of Direction that they assign to the committee the investigation of the various kinds of signs for railroad purposes as applicable to both employe and the public.

C. H. Stein (C. R. R. of N. J.), chairman; G. E. Boyd (D. L. & W.), vice-chairman; R. B. Abbott (P. & R.), H. E. Billman (M. P.), E. T. Brown (B. & O.), J. T. Frame (C. G. W.), C. M. James (A. C. L), L. C. Lawton (A. T. & S. F.), G. L. Moore (L. V.). J. B. Myers (B. & O.), F. M. Patterson (C. B. & Q.), C. H. Splitstone (Erie), W. F. Strouse (B. & O.), W. D. Williams (Cin. Nor.), committee.

Discussion on Signs, Fences and Crossings.

Richard L. Humphrey: The committee recommends that the reinforcement be about one-half inch from the surface, and also recommends, not the mixed gravel, which is excellent, but says "gravel or crushed rock." I think it will be

found where the crushed stone is rather soft or is a stone with high absorptive qualities, that there may be trouble encountered by having that material in a fence post. The gravel or crushed rock used in the post should be a hard, dense material with slight absorptive qualities, or it will cause the destruction of the post.

Mr. Stein: I move the adoption of conclusions 1 to 10 under Fence posts and that the conclusions and recommendations be substituted for those in the 1911 Manual of Recommended Practice.

Mr. Humphrey: I suggest that we put in the fifth conclusion "gravel or crushed rock of low absorption."

The President: The committee will accept that.

S. A. Jordan (B. & O.): I ask why, in conclusion 9, the posts should be cured for not less than 90 days before being sent or shipped?

Mr. Stein: It is the opinion of manufacturers of concrete posts, and I say this with the support, I believe, of every manufacturer of concrete posts, that under all circumstances they should be cured for not less than 60 days. That means a seasoning process, and while it would appear that a small mass of concrete like a post would dry out or season and cure within a comparatively short period of time, it has been found by experience that is not the fact and that it really requires at least 60 days, and the statement is made that 90 days is preferable in every case before the concrete post reaches its full strength, and even after that it continues to grow in strength, and that is the experience with respect to other forms of concrete. We thought we would be on the safe side and specified 90 days. If the users desire to cure the concrete for only 60 days, that is a matter within their own control and they can substitute 60 days for the 90 days.

Mr. Humphrey: The committee might consider the question of steam curing, which is a matter of accelerating the interval between the making and use of the post. With the use of a proper system of steam curing the time can be reduced.

E. V. Smith (B. & O.): In conclusion 7 the committee say that the posts should not be exposed to sun. Why should that not read, "should not be exposed to sun or artificial heat"? Why not have that apply to artificial heat also, in extreme weather.

Mr. Stein: Some manufacturers of concrete posts cure their posts by steam—that would be the application of artificial heat. The committee thought it would not be well to make any change in that conclusion at this time. The object of not exposing the posts to the sun is to prevent the cracking or alligatoring of the posts. There is also a provision in conclusion 7 that the posts should be sprinkled. That is to allow for the complete absorption of the moisture and the compacting of the material and the seasoning of it.

Mr. Humphrey: I think conclusion 9 should have some explanatory note. That 90 days applies to natural curing. Where steam curing is used the time should be less. As this is to go into the Manual there should be some explanatory note.

The President: What would you suggest, Mr. Humphrey?

Mr. Humphrey: I would suggest a note be added reading, "90 days when cured naturally."

The President: The committee will accept that.

(The motion to adopt the recommendations of the committee, covering conclusions 1 to 10 and also the publication of the conclusions in the Manual, was adopted.)

Mr. Stein: The second subject referred to the committee was, "Track Construction and Flangeways at Paved Street Crossings and in Paved Streets." We secured all available data and it was our conclusion that the form of track construction and flangeway at paved street crossings and in paved streets should be as given here.

E. V. Smith: Why should we specify, in the first paragraph, a maximum depth of not "more than 12 in."? I think that should be omitted.

Mr. Stein: There may be some remote cases where more than 12 in. are necessary, but where you have fairly good supporting ground and you put in more than 12 in. you may have to resurface the track more frequently on account of the gradual settlement or compacting of the balance. I realize that the investigations of the Ballast Committee have shown that the greater the depth of ballast the more evenly the load is distributed, but this is the result of the experience of those roads which have tried it, and we have felt that from 8 to 12 in. was a proper margin.

J. S. Campbell: I am surprised that even 8 in. of ballast will properly support a railroad track across a paved street, without a degree of settlement which will interfere with the traffic on the track. I ask if the committee has any information as to what extent the city will permit that form of construction. In El Paso they require a solid concrete foundation and on our own account, we have found it very desirable, at least, if not absolutely necessary, to have the track in perfect surface, so that they will not have to repair the crossing frequently, and for that reason we make a solid concrete foundation.

F. P. Patenall (B. & O.): I would suggest that the note specifying the "concrete packing" be left blank, and another note put there "as specified."

Mr. Stein: One of the members of the committee calls attention to the fact that one of the points we have been talking about is covered in the text of the report. If members had read this paper they would have learned something about it in better form than I can express it.

Mr. Patenall: Under "Recommendations" we are asked to have this included in the Manual, and I suggest that if there are other parts of the report which refer to concrete packing that the matter should be cleared up.

Mr. Stein: The committee will withdraw the note "Concrete packing" and just say "form of packing."

Mr. Ferriday: It seems to me that it is unnecessary and contrary to what we know about ballast to specify that there shall not be more than 12 in. of ballast. The Pennsylvania Railroad made tests, and I think the committee on Ballast made some report, in which they showed that an increase of the ballast to a thickness of perhaps 18 to 24 in., reduced the cost of maintenance. In explanation of why that is given as a maximum of 12 in. in the specifications before us it is said that some of the New York Central track settled where they had 12 in., but did not settle where they had 4 in. I think in the case of any fresh track put down we would have to wait some time until it settled and that might possibly take longer time with a deeper ballast than 12 in., but it does not seem to me that it is desirable to go on record and put in the Manual that 12 in. should be the maximum. I therefore make a motion to omit the words "not more than 12 in." in the second paragraph.

The President: The committee will accept that.

Mr. Jenkins: I suggest changing the plan to conform. There is a note, "8 to 12 in. for ballast." That should not be less than 8 in.

(Motion to adopt the specifications as read was carried.)

Mr. Stein: The third subject to be considered is "Continue the investigation of ways and means for securing a proper quality of fence wire to resist corrosion and secure durability." Unfortunately, the tests which were being conducted at Carnegie Institute, at Pittsburgh, were abandoned some time ago. We, therefore, recommend to the Board of Direction the discontinuance of this subject.

MASONRY.

The work assigned by the board of direction was as follows:

(1) Report on waterproofing of masonry and bridge floors, including methods, cost and results, with definite recommendations.

(2) Report on the effect on concrete structures of rusting of the reinforcing material.

(3) Report on the principles of design of plain and reinforced concrete retaining walls, abutments and trestles.

As the subject of waterproofing is a large one, in which materials and new methods are coming into use all the time, it has been found impossible to submit a satisfactory report at this time.

The sub-committee has done a great deal of work during the summer and fall on the principles of design of plain and reinforced concrete walls, abutments and trestles in the way of investigation and gathering together information as to their design. They also made some effort to get some money from the board of direction and individual subscriptions in order to make a test of a section of a large size retaining wall, but were unable to obtain the necessary money to make this test. It is hoped the board of direction will see their way clear to authorize this test this coming year. Other than this, the committee has no report to make.

During 1912 the joint committee on concrete and reinforced concrete has revised its previous report, to which has been added some new matter and the whole brought up to date. The report will be available to the various societies represented, including the American Railway Engineering Association, in the near future.

During the year meetings of the joint committee on Standard Specifications for Cement were held in an effort to harmonize the differences between the American Society for Testing Materials and the Government Engineers, and acting upon a resolution, representatives from the American So-

ciety of Civil Engineers, the United States Government, and the Society for Testing Materials were requested to confer relative to these differences. This conference had its initial meeting October 24, 1912, organized, and has been carrying on such investigation work as may lead to an agreement on Uniform Methods of Tests and Standard Specifications for Cement.

G. H. TINKER,
Chairman Committee on Masonry.

G. H. Tinker, chairman (N. Y. C. & St. L.), F. L. Thompson, vice-chairman (I. C.), Robert Armour (G. T.), G. J. Bell (A. T. & S. F.), C. W. Boynton (Univ. Port. Cem. Co.), T. L. Condron (Cons. Engr.), J. K. Conner (L. E. & W.), L. D. Crear (Erie), L. N. Edwards (G. T.), A. H. Griffith (B. & O.), G. W. Hegel (C. J.), L. J. Hotchkiss (Found. Co.), Richard L. Humphrey (Cons. Engr.), W. H. Peterson (C. R. I. & P.), Philip Petri (B. & O.), J. H. Prior (C. M. & St. P.), F. E. Schall (L. V.), G. H. Scribner, Jr. (Contr. Engr.), A. N. Talbot (Univ. of Ill.), Job Tuthill (K. C. Term.), J. J. Yates (C. R. R. of N. J.), Committee.

APPENDIX A.

Disintegration of Concrete and Corrosion of Reinforcing Metal.

In cases where disintegration of concrete and corrosion of reinforcing metal are under investigation attention should be directed to the quality of the concrete, to the concrete materials, and to the workmanship before any conclusions can be drawn as to the effect upon good concrete of the deteriorating agencies present. In deciding upon preventive measures again due, attention to materials and workmanship will usually prove to be the most effective.

The failures of concrete structures most commonly reported are those due to faulty design, including details, use of improper materials, poor workmanship and neglect of proper precautions in removing forms and applying loads and otherwise overstressing new concrete structures.

While the subject of failures due to these causes is not considered to be included under the committee's assignment, they are sometimes wrongly supposed to be due to the disintegration of concrete. Failure to properly provide for shrinkage of concrete due to hardening in air, and for expansion and contraction due to temperature changes, is a common cause of cracks which may lead to failures.

The requirements for good materials have been described in numerous texts, specifications and reports, together with the methods of determining whether or not the materials meet the requirements. However, the proper precautions are not usually observed in choosing materials, especially aggregates. Although good concrete can be made with crushed stone screenings as fine aggregate, the results of laboratory tests on this material are likely to be misleading, and tests on specimens made to reproduce as nearly as possible field conditions of mixing, placing and hardening are especially desirable when screenings are used.

To obtain good work, competent and ample supervision is necessary, and no expedient can be resorted to that lessens the requirements for workmanship. In practically all cases where failures have been investigated, it has been found that the workmanship could have been improved with profit. Probably the most common cause of failures of concrete structures has been the premature removal of forms. It has been definitely established that low temperature retards the hardening of concrete, and in work done during cold weather, precautions should be taken accordingly.

Investigations concerning the effect of sea water on concrete immersed for periods up to fifty years or more; of the relative merits of standard Portland cement and Portland cement made with varying contents of SO_3, MgO, CaO, Fe_2O_3, Al_2O_3, SiO_2, etc., in resisting the disintegrating effects of sea water; of the effect of varying the proportions of cement in the mortar and concrete; of the addition of various finely ground materials to the cement after burning; of the relative durability of concrete cast in place as compared with concrete blocks allowed to harden before placing in the sea; and of the effect of various materials added to the concrete mixture to produce impermeability and consequent increased durability have been made in various European countries and in America.

Regarding the chemical composition of the cement, the following conclusions are presented: Cement containing up to 2½ per cent. of SO_3 resist the action of sea water fully as well as cement with lower SO_3 content. While all the hydraulic cements now in use are liable to decomposition in sea water, Portland cement is the one to be preferred in every respect. High iron Portland cement and puzzolan cement have failed to show superiority over standard Portland cement in resisting the disintegrating effect of sea water.

Regarding the effect of varying the proportions of cement in the mortar and concrete, in general the richer mixtures have been found to offer better resistance to the attack of sea water. Proportions recommended for mortars are those with one part cement to one part of sand up to one part cement up to two parts sand. The bad condition of mortars leaner than the above, after exposure in sea water, stands out prominently. In the use of reinforced concrete for maritime works, it is advisable to employ larger proportions of cement than are usual for similar works in fresh water.

Concerning the addition of finely ground material to the cement after burning, it has been found that the addition of ground puzzolan or furnace slag to Portland cement increases the resistance of the resulting mortar or concrete to the disintegrating effect of sea water. Allowing the concrete to harden under favorable conditions before exposure to the action of sea water greatly increases its resistance to attack by the sea water and is recommended wherever possible.

When concrete is deposited under sea water such precautions should be observed as will prevent the washing of the cement from the mixture. Forms should be so tight as to prevent the entrance of sea water after depositing the concrete in order that a smooth surface may be obtained sufficiently rich in cement to be impermeable after properly hardening, and with the forms removed.

Where the effect of sea water on concrete has been other than mechanical, it is believed that disintegration is caused by the substitution of MgO from the sea water in the place of the CaO of the cement, as well as to the decrease in the proportion of silica and the increase in SO_3.

The making of a dense, impermeable concrete by the use of a well graded aggregate, rich mixture, proper consistency, and good workmanship, and allowing the concrete to harden under favorable conditions before being exposed to the action of sea water, are generally conceded to be efficient means of satisfactorily insuring the preservation of concrete in maritime works.

Investigations concerning the effect of ground waters which contain acids or alkalies on concrete drain tile, sewers, tunnel linings, etc., and of the effect of sewage on concrete used in sewers and disposal works, have disclosed several instances of apparent disintegration. The following points have been demonstrated in regard to the resistance of concrete to these agencies. Drain tile which, due to the use of poor aggregates, improper methods of manufacture or the use of lean mixtures are porous, may be affected by the soil acids found in some localities or when required to carry strong alkali seepage common in many irrigated sections of the western United States. The aggregate should be composed of materials inert to the acids or alkalies present in the water. A chemical examination of the sand from country known to contain alkaline soils is to be recommended.

Water containing substances known to react with the elements of the cement should be kept from coming in contact with concrete until the latter has thoroughly hardened. Care should be taken to provide a smooth surface and sufficient slope to the extrados of the arch of tunnel linings and sewers when the ground water level lies below the tunnel grade to facilitate the flow of seepage water to the sides. It is believed that the back filling over the arch ring should consist of porous material, such as coarse, crushed stone, for the same reason. It is also believed that side drains should be

provided where necessary and connected with an under drain, which should be provided in all cases. The alkalies which are most active in causing disintegration of concrete when allowed to penetrate into the interior of the mass are the sulphates of sodium, magnesium and calcium.

The measures to be used in making concrete which is to be exposed to the action of these deteriorating agencies in order to prevent disintegration are the same as recommended for sea water construction. Impermeability is the prime requisite and the results of experiments and practical tests indicate that plain concrete, carefully prepared, is just as resistant, if not more so, than concrete mixed with foreign materials or special preparations.

Disintegration of concrete in sewers and sewage disposal works, whether due to the use of poor materials, poor workmanship, or insufficiently rich mixtures, has been found to take place above the normal surface of the liquid contained. The following explanation is advanced for this action. Quantities of hydrogen sulfid are evolved from the sewage. This sulfid is produced in two ways: (a) By the bacterial decomposition of sulphur-containing-proteins and related compounds, and (b) the reduction of sulphates which are contained in unusual amounts in some water supplies. Of the two, the second seems to be the more important. The hydrogen sulfid which escapes as gas from the sewage is partially dissolved in the moisture on the under side of the roof and concrete walls. Here it is oxidized to sulphuric acid partly by atmospheric oxidation and partly by bacterial action. The sulphuric acid acts upon the calcium compounds in the concrete forming calcium sulphate and breaking down the concrete.

Cinders with much sulphur are likely to give unsatisfactory results in concrete, especially if there is much coke or porous material present. Such cinders may be improved if allowed to weather, with occasional washing, until the ferrous iron and sulphur have been oxidized and bleached out. Porous cinder concrete in roofing slabs exposed to the action of locomotive gases does not form an efficient protection for reinforcing metal, which has been found to corrode and cause the disintegration of the slab. Freshly made concrete surfaces in contact with smoke gases at temperatures below 45 deg. F. have failed to harden properly, and experiments indicate that under such conditions the cement is acted upon by some of the gases. It has therefore been recommended that when heating is done by means of open fires, higher temperatures should be maintained.

Laboratory experiments furnish most of the information which exists concerning the effect of electrical currents on concrete and reinforcing metal. The discrepancy between the conditions in these experiments and field conditions seems to be greater than is the case in other laboratory tests on structural materials, and the information obtained up to this time is difficult of application to field conditions. It has not been shown that the strength of plain concrete is affected by the passage of an electric current through it. It is generally accepted that if an electric current passes into concrete through steel which is tightly embedded in it, the steel is corroded and the expansion of the metal, due to corrosion, disrupts the concrete. Corrosion takes place at the anode. The cathode is not affected by oxidation.

Results of experience up to date have shown no reason for changing the conclusions presented in the progress report of the joint committee on concrete and reinforced concrete, 1908: "Tests and experience have proved that steel embedded in good concrete will not corrode, no matter whether located above or below fresh or sea water level. If the concrete is porous, so as to be readily permeable to water, the metal may be corroded in the presence of moisture."

Discussion on Masonry.

Mr. Thomson: The chairman of the committee, Mr. Tinkar, has been ill practically all of the year, and the work of the committee has been handicapped on this account, and the report of the committee, while it is in good shape, is not in proper condition for publication, and the committee expects to get the matter in better shape by the next meeting. The committee also desires to state that the Appendix A has been printed without the consent of the committee and requests that it be withdrawn.

(The report of the committee was received as a report of progress.)

FOUND.

A Masonic emblem was found yesterday at the Coliseum. It is now in the office of the secretary of the N. R. A. A. at the Coliseum, where it can be claimed by the owner.

THE ANNUAL DINNER.

The fourteenth annual dinner of the American Railway Engineering Association was given last night in the gold room of the Congress hotel. President Charles S. Churchill was toastmaster and the speakers and their subjects were: B. A. Worthington, president of the Chicago & Alton, "Looking Into the Future"; Rev. R. W. Dickie of Montreal, Canada, "Internationalism"; George A. Post, president of the Railway Business Association, "The Effect of Music Upon Railways," and P. G. Rennick of Peoria, Ill., "The Twentieth Century Pattern." Mr. Rennick is connected with the Columbia Bureau of Lyceum Talent.

The dinner was one of the most successful in the history of the association. The attendance was unusually large. The addresses of Messrs. Worthington and Post both dealt with the public relations of the railways. Mr. Worthington's was a serious discussion of the situation, and Mr. Post's was a mixture of the facetious with the serious, and both were listened to with great attention and enthusiastically received. Rev. Mr. Dickie talked on "Internationalism." He discussed the relations between Canada and the United States, indicating his belief that annexation would never come, but that the two countries could draw closer and closer together with advantages to both.

The addresses of Messrs. Worthington, Dickie and Post were as follows:

Mr. Worthington on "Looking Into the Future."

It is needless for me to say that I fully appreciate the high honor of addressing your association at its annual banquet; but it is with some degree of hesitancy that I assume to appear before a body of professional men whose fundamental requirement in order to qualify in their calling is a most liberal technical education; gentlemen who, I might say, represent the culture and aristocracy of the railroad profession; and I might also say with sincere candor, gentlemen who, as we all know, represent the only branch of railroad service where the rules and practices are based upon exact science. Of course, I will admit that sometimes a premise may be wrong, but the conclusions of our engineers are always based upon sound formulae—or empirical deduction.

With the permission of the chairman of your entertainment committee, I have selected for the subject of my address "Looking Into the Future," and with your kind indulgence, I shall take as my text an article appearing in the March issue of the World's Work, entitled "What I Am Trying to Do," by the Honorable Franklin K. Lane, late chairman of the Interstate Commerce Commission, recently appointed Secretary of the Interior, in which article Mr. Lane says: "We are seven, but we work as one."

In the concluding paragraph he states:

"The men who actually operate our railroads, who keep the intricate wheels of this mighty machine constantly in motion and always at our service, receive too little public acknowledgment for the work they perform. They are among the most skilled, capable and honest of our business and professional men. They have an enthusiasm in their work and a loyalty to their companies that is a constant satisfaction, and their delinquencies too often may be traced to policies which purely as railroad men they would not countenance. With these men we can work, and through them we may hope for the realization of a national system of railroads that will be fair as to rates, profitable as to income, and adequate as to service."

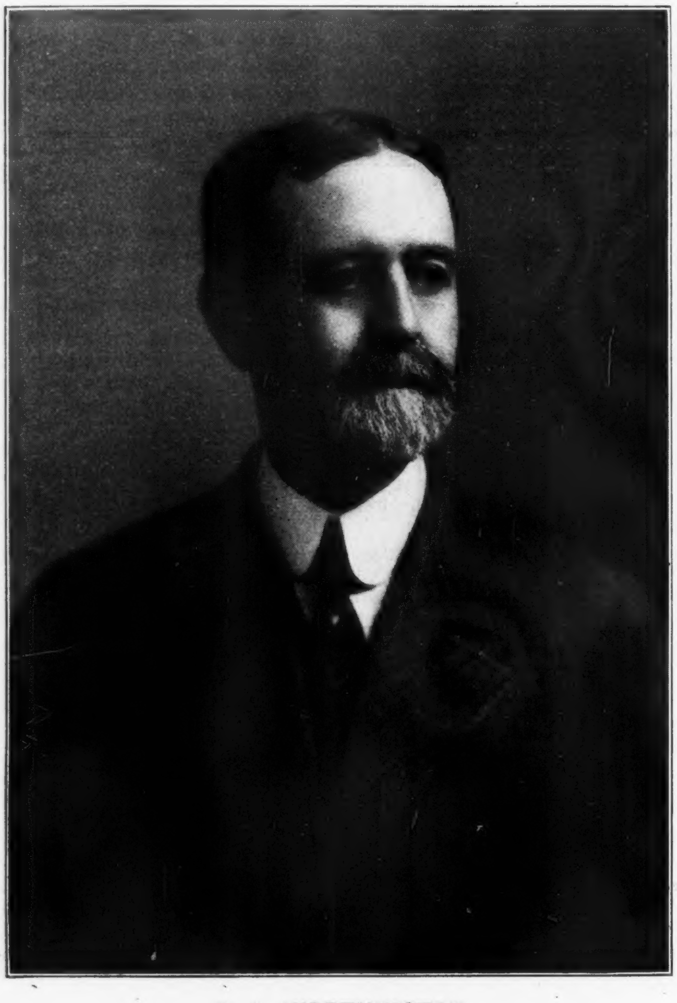
As many of you know, I am a native son of the Golden West, having been born and raised in California, and I have had the honor of a personal acquaintance with Mr. Lane for over a quarter of a century. While he was once an earnest advocate of government ownership of the railroads, in the fifth paragraph of the article above mentioned he says:

"Our primary object must be to prove the efficacy of the machinery devised by law for bringing the policy of our railroads into conformity with the policy of the law—to make private capital serve public need and yet conserve the interest of the railroad owner. The public wish the best of service at the lowest possible rates; the owners desire the highest return consonant with the fulfillment of their undertaken duties. This may be an *impasse*—a situation so impossible of resolution that we are destined to join *those nations who are experimenting with governmental ownership*

and operation. That stage of despair, or of resolution—dependent upon the viewpoint—we, however, have not yet reached. In fact, I believe we are far from it, for we have only entered upon the experiment of regulation by commission, and students of this subject from other lands have said that their countries would not have sought refuge in governmental ownership had they in time discovered the American method of dealing with the railroad problem."

Briefly reviewing the situation, taking a back sight into the past to establish a foresight into the future, let us summarize the known quantities with which we have to deal, formulate our equations and theories and project them into the future as best we may.

Commerce is defined as the taking of things from the place where they are plentiful to the place where they are needed, and it has been well said that the degree of civilization enjoyed by a nation may be measured by the character of its transportation facilities. This is true not only of modern nations, but of all nations of which we have authentic history. The most advanced nation has always excelled in commerce and wealth, and the economic measures adopted for the furtherance of these interests have evolved civilization, which in itself is merely improvement in arts and learning.



B. A. WORTHINGTON.

COMMERCE THE FORERUNNER OF CIVILIZATION.

Among the first great nations of which we have positive knowledge were the Phoenicians, who for nearly two thousand years enjoyed the commercial supremacy of the world. Out of the necessities of their expanding commerce they invented numerous devices, many of which, withstanding the severe test of time, have been preserved for us, indispensable to modern civilization. They invented, for instance, an alphabet of their own representing sounds, because the picture writing of their neighboring nations could not be adapted to the needs of commerce, and their alphabet has been handed down to us of today as the greatest of all inventions. Before the Phoenician alphabet came into general use, history is dark, save for the flickering sparks of civilization commemorated by representations of visible objects, the meaning of which so often is conjectural.

Each subsequent nation which has risen to prominence has contributed its share to civilization, but only because of the exigencies of commerce and that indispensable factor of commerce—transportation. Wherever we may look, we shall find that commerce is the hand that shapes the destiny of nations, the agency which most needs and best utilizes the factors of civilization—art and learning.

China, with her yet primitive transportation facilities and necessarily restricted commerce, is an up-to-date object lesson in this respect. The accredited inventors of printing and explosives, those wonderful agencies of progress and defense, the principles of which have been known to the Chinese for over one thousand years, yet in all that long period not one Chinaman out of a total of three hundred million living population had even the faintest conception of the value of their inventions—because the spurs of commerce were unknown to them, and their simple defenses were best accomplished by stone walls of commercial isolation. It is of peculiar interest that the Chinese worship a fabled dragon, an object of terror, while our own forefathers worshipped their sacred bull, the carrier of their burdens, an emblem of progress.

Within the past few years, however, China has been awakened by the shrieking locomotive and the rumbling wheels of commerce, the introduction of modern business facilities marking the end of long centuries of domestic slavery, appalling pauperism, and thieving hordes which for generations have thrived upon their depredations—the theory of the ancient Chinese government being exploded with the gun powder of their own making.

NEW THEORIES OF GOVERNMENT.

In America, independence, having its birth in the memorable events which led up to the activities of the Boston tea party—an open rebellion against the restraints which England sought to impose upon American commerce—has advanced new theories of government. In the application

of these theories many new conditions have been encountered and many perplexities have arisen to tax the wisdom and the courage of our most learned and capable men. In the past we have surmounted all these obstacles because we have always been able to find amongst us somewhere a man of the hour with conviction and courage of conviction equal to the occasion—and we have passed through some crucial tests. The nation has been torn asunder, the North and the South have faced each other with dripping swords, but we have never before encountered a situation so insidious of growth and so seriously affecting the bone and sinew of our strength, yet so full of promise, as the railroad situation of today. We are again wintering Valley Forge, internal discontent and conflicting elements adding to the difficulties of a seemingly impossible task. Let us hope with Mr. Lane that with the men who will answer the call final results may be realized which will be fair and adequate for all.

REBATING INEVITABLE UNDER KEENLY COMPETITIVE CONDITIONS.

During the past half century the railroads have been developing the resources of this country in a perfectly natural way. That certain abuses have crept into their methods is not at all surprising, for wherever active competition exists we shall always find abuses of a more or less serious nature; and when the apparently ideal methods of small business are applied by a sensitive, active, alert organization to a business having a net capitalization of $14,000,000,000, relatively unimportant shortcomings are wonderfully magnified and assume unusual significance. Yet during this period of rebating, discrimination and kindred evils, the wealth of the United States increased from $7,000,000,000 in 1850 to $107,000,000,000 in 1904, $65,000,000,000, or over half of this enormous wealth, having been developed during the last twenty-four years of this period, while the pernicious practices so often referred to were under full sway. From this point of view the matter of rebating, etc., dwindles to relative insignificance, for we must bear in mind that this enormous wealth is *substantial* wealth, invested in the gilt-edged securities of farm lands, city property, industrials and public utilities, all enhancing in value dependent entirely upon future development of railroads.

But I hold no brief for the rebating system or discriminatory practices. No right-thinking railroad man in the country is but thankful that these days of extortion are passed forever. Nor do I claim that railroad business methods or conditions are yet perfected, but in justice to the sensitive economic features involved, I do plead for the most careful premeditation, and that should doubt arise in regard to any features, it should be carefully hedged in with all the proper safeguards of public welfare, bearing in mind the all-important lessons of history, and that economic and natural laws are always superior to statutory enactments and must not be disregarded.

MEETING CONDITIONS OF THE FUTURE.

The railroad situation at the present time is as delicate as it is complex. In the decade 1890 to 1900 the volume of freight traffic handled by the railroads was doubled, and in the following decade it was doubled again—and still the end is not in sight. Our farms are yielding but a small proportion of the crops that are possible by intensive cultivation. The density of our population is less than 31 persons to the square mile, while the population of the United Kingdom is 373 and that of Belgium 660 to the square mile; and if we project a line into the future from the point which we have established in the past, we cannot misapprehend the further development which lies directly before us.

But whether the volume of business increases or whether it decreases are speculative conditions, alike threatening to the railroad situation. An increase in the volume of business is an absolute necessity under present conditions of reduced net earnings per unit of service, but to provide facilities to handle an increased volume of business is a financial impossibility unless new capital can be induced to enter the field of railroad investment.

In referring to this phase of the question, Howard Elliott, president of the Northern Pacific railway, a man who has fought his own way from the humblest ranks to this position of eminence, stated in a recent address that there should be $1,700,000,000 new capital put into the transportation business of the United States each year for the next five years—a total of $8,500,000,000, or 60 per cent of the present calculated value of all our railroad property. This practically amounts to reconstruction throughout in order to handle the business now offered and make suitable provision for what we *know* is ahead of us. This means the replacement of obsolete equipment, the elimination of grades, double-tracking, safety appliances, also innumerable non-productive improvements, such as the elimination of grade crossings, modern station facilities, etc., demanded by the public—in short, better and safer transportation throughout.

The expenditure of $1,700,000,000 new capital each year for the next five years would not mean that the wealth of this country would be decreased to this extent. Far from that! It would mean that this amount of money would be spent for labor and materials right here at home, and every cent of it would revert to the people in the most satisfactory forms acceptable to them. What a glorious vision of prosperity this presents!

GOVERNMENT REGULATION NOT OBJECTIONABLE.

The original founders of our railroad systems, visionary though they may have been and doubtless were, could never have thought possible the wonderful development and the amazing prosperity of the past twenty years. History presents no precedent, simply because the possibilities of transportation have never before been so thoroughly exploited. Neither could this development have been possible, save for the acute business instincts of private ownership of railroads and the widest freedom of individual initiative, neither of which could survive government ownership or government operation.

Government control is not at all objectionable to the railroads; in fact, it is a necessity; and its restraining influences are entirely wholesome. In many respects the government has already produced results which the railroads could never hope to accomplish—such, for instance, as the elimination of rebating and other discriminatory practices inherent to active competition, all of which practically have been abolished from the sphere of railroad operation.

But in paring down the claws of this alleged monster, the railroads—a regular Chinese dragon to those less familiar with their economic and strategic uses, still the same sacred carrier of burdens and the emblems of progress that our ancestors worshipped forty centuries ago—they have cut into the quick, and until the wound heals by natural processes, progress will be crippled. In taking away from the railroads the prerogative of rate making and by prescribing numerous restrictive conditions of operation which tend to reduce revenue and increase expenses, they have taken away from the railroads their natural weapons of offense and defense, and have left the railroads apparently at the mercy of an unsympathetic public, which, laboring under grave misapprehension, sees nothing but misdeeds, naturally, artificially and oftentimes maliciously, magnified.

RAILROAD FACILITIES INADEQUATE TO MEET REQUIREMENTS.

Owing to this unfortunate state of affairs, the railroads of the United States have now reached a stage where they are unable to provide adequate terminal facilities where they are most urgently required, and where congestions recur annually, lasting for months at a time, regardless of the extreme shortage of equipment. The steadily decreasing margin of safety in railroad operation, amounting to substantially 28 per cent in the past ten years, has made it compulsory upon the part of the railroads to cut maintenance charges, and accordingly the physical property—roadway and rolling stock—has in many instances been sacrificed to produce even these results, and visions of the future have become obscured by the run-down conditions of today.

RAILROAD VS. INDUSTRIAL RETURN ON INVESTMENT.

Turning from this unpleasant aspect, in the shadow of gloom which has fallen upon the railroad situation the investing public looks askance at the red figures in income account, like fire destroying property values, and turns reluctantly to industrials, where obscurity seems to promise security, where the net return upon capital invested is more than twice as great as in railroads, where the public is not a factor to consult, and where the government is in no wise sponsor for results.

That the railroads should expect to share in the general prosperity of their own making is not surprising—excepting that the railroads yield by 5.7 upon investments, while manufactures yield over 12 per cent, and the value of farm land and city property is appreciating in value so rapidly that comprehensive data is not available. In view of the risks assumed in railroad undertakings, the developments which they have always encouraged, and the excellent service which they are rendering to the public even under the present restrictive conditions, it would appear that more encouraging results should be possible along this line of investment, as a more substantial guaranty of public safety, financially and commercially. The suggestion that railroad investments should earn as much as investments in manufactures, for instance, is not out of order, because the right to earn a reasonable profit upon legitimate investment is

all that is asked for, and the improvement of railroad property and the enlargement of its facilities is a matter of urgent public necessity. This menace of financial impossibilities thrust upon the railroads should be speedily removed as a restraint to commerce, which, in fact, it is, and in no small measure.

DIVIDENDS ON RAILROAD STOCKS.

In the matter of dividends on railroad stocks, the impression seems to prevail that a dividend of, say, 7 or 8 per cent stock would be equivalent to throwing that much wealth into the sea, when, in fact, it would merely revert to the people—to the widows, orphans, business men, financial and endowed public institutions, where it would be reinvested immediately in one highly desirable form or another. Certainly this would be no crime. It would be an economic condition much to be preferred to the closed shop, with roundhouses standing full of crippled locomotives, yards filled with bad-order cars, roadway neglected because of financial stringency, and wasteful congestions prevailing—all resulting in unsatisfactory service to patrons, unsatisfactory results for the railroad managers, and a passing of dividends for the shareholders. The question is who *does* get any benefit from this condition of affairs?

RAILROAD SECURITIES HELD ABROAD.

Another phase of this question, one which should cause the deepest reflection, is the fact that from 20 to 25 per cent of our railroad securities are held abroad. With private ownership of railroads as it exists today, it is useless for the government to attempt to evade the responsibility for the depreciating values of these securities, which are being returned to us under protest. Our "commerce laws" originally were enacted for the protection of bona fide investors in railroad securities and to prevent practices that could not be measured by a strict code of business justice, and if we would avert national dishonor, more undesirable than anything else that could happen, we should be ever conscious of this delicate situation and leave nothing whatever undone to satisfy in the fullest measure our pledges of faith held abroad.

The armies and navies of the world have always existed primarily for the protection of commerce. Relentless wars have been waged, and shall yet be waged, because of conditions that affect national wealth and national welfare, and nothing affects national wealth and national welfare as do conditions of commerce.

No individual has ever knowingly sought to destroy a source of his income, but he will fight, and fight to the death, to preserve it. Nations are merely groups of individuals, none the less sensitive and responsive to these same conditions, and as long as foreign capital invested in American railroads yields just and satisfactory returns to the strong financial institutions of Europe, their dogs of war will ever remain chained up at home, American railroad securities will be our national security—not the misnomer they seem to be today—and the International Peace Conferences at The Hague will be merely a waste of effort so far as America is concerned.

This condition of affairs is peculiar to America alone. It is one of our most valuable assets, the most formidable defense that any nation has ever erected. Let us not tear it down with our own hands.

Moreover, we are now approaching the time when it will be possible to materially strengthen this position, when securities must be floated for the $8,500,000,000 which should, and must, be put in our transportation system within the next five years, and we cannot afford to ignore the opportunity that is now knocking at our door.

JUDGE KNAPP AND COMMISSIONERS LANE AND PROUTY AGREE.

In this tangled web of conflicting conditions now lying before us, I believe that the ends have finally been gotten together. I believe the crisis is passed—even perhaps as our eminent authority, Mr. Lane, expresses the thought respecting government ownership: "That stage of despair, or resolution, we have not yet reached."

In his fine, deliberate, cautious manner, possibly the question of government ownership and operation of our railroads may have slipped by unobserved and into oblivion with the changing of his own attitude upon this point. Let us hope that it has.

In the beginning of his article to which I have referred, Mr. Lane states in regard to the personnel of the Commission:

"It would be hard to find seven men who differ more in temperament, in training, or in type of mind, than the present commissioners. We differ as one leaf from another in our political sympathies. Often we do not arrive at our conclusions from the same strategic angle."

Yet it is worthy of note that Mr. Lane's predecessor, the Honorable Charles A. Prouty, ex-chairman of the Interstate Commerce Commission, a man who, like Mr. Lane, has made a life-long study of the perplexing railroad problems, has stated:

"If the time does come when railroad property is sacrified to public clamor, when the public demands its confiscation and the regulating tribunal concedes that demand, no property will be of much value. The day will have come when the obligation of private rights is no longer observed."

The Honorable Martin A. Knapp, likewise an ex-chairman of the Interstate Commerce Commission, a tireless student of the railroad situation, and one of the most profound thinkers in this country, expresses his thoughts as follows:

"I should regret to see the government take up the business of owning and operating our railroad lines."

It would, therefore, seem that these three able analysts, individually and by different methods, have arrived at about the same conclusion—that the square of commercial condition cannot be made to fit satisfactorily into a theoretically perfect circle of public ownership.

When this question is finally and definitely disposed of, we may proceed more understandingly and along more scientific lines to pursue the cause of higher civilization.

RAILROAD MEN MAY BE RELIED UPON TO AID COMMISSION.

The clarifying of the railroad situation may yet take years to accomplish, for it must necessarily be a slow and careful procedure; and in the efforts of the commission to untangle this web of misunderstanding and misdirected efforts no right-thinking railroad man, no public-spirited man, whatever may be his calling, should withhold his fullest support and his warmest encouragement. The railroads, having nothing to fear, I am sure will, as a unit, welcome and enthusiastically embrace the opportunity to work in full harmony with the commission and for the common cause of the people, including not only patrons of railroads and railroad employes, but also the holders of railroad securities and the public generally—a happy solution which in itself will contain all that is desirable in government ownership or operation, and yet will maintain the constitutional rights of private property and preserve the spirit of industrial freedom and the incentive for individual initiative which in the past twenty-four years have wrought a stupendous wealth, regardless of all our shortcomings.

LOOKING INTO THE FUTURE.

That we are nearing a satisfactory solution of this entire railroad problem, I am convinced. The fact is clearly demonstrated by the three opinions herein cited, those of the three ex-chairmen of the Interstate Commerce Commission, each arrived at entirely independently of the others and very probably from entirely different strategic angles.

Furthermore, in stating his views before the Traffic Club of Pittsburgh less than a year ago, the Honorable Charles A. Prouty used the following language:

"No form of investment today is, and no form of investment in the future will be, more certain than railroad stocks and bonds. . . . The worst that could happen to the stockholder of any of our great railway systems would be a temporary suspension of dividends, and even this could occur only under very unusual circumstances."

In view of the unanimity of opinion and the unqualified assurances emanating from an undisputed authority, the Interstate Commerce Commission, I feel confident that the reins of the situation are in careful hands and that we will yet be able to demonstrate the truth of the assertion that "the degree of civilization enjoyed by a nation IS measured by the character of its transportation facilities."

Therefore, with a full knowledge of what we are trying to do, conscious of the tremendous task before us, and the wonderful possibilities that are contingent upon the *correct* solution of the present-day railroad problem, now is not the time to lament what has happened, or what may have happened in the past, but with unwavering faith in the wisdom and integrity of our able Interstate Commerce Commissioners, generals of the greatest army that ever entered a field of conquest, let us set about to build our bridges into the future—bridges big enough to span any depression which we might encounter in the commercial conditions before us, bridges strong enough to withstand the test of prosperity which we have already sighted over the established points of the past.

"Internationalism," by Rev. Robert W. Dickie.

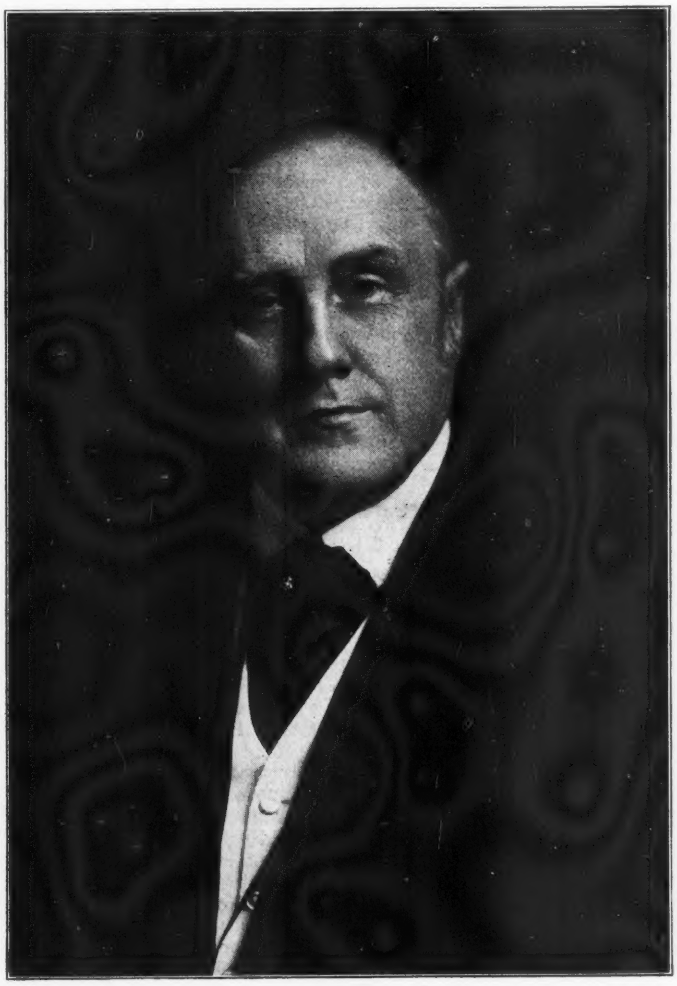
I suppose I shall have to note this as the great day of my life so far—my first visit to Chicago. I don't see how I have managed to live as long on this continent without seeing Chicago and tasting its life. I assure you, gentlemen, now

it has come to pass, I like it very much. I suppose I have to thank your ex-president, Mr. McNab, for this pleasant experience. For the past few years Mr. McNab has been bringing you over a series of distinguished Canadians. I think you have had the Hon. G. W. Ross, ex-premier of Ontario; the Hon. Geo. P. Graham, ex-minister of railways, and the Hon. F. D. Monk, ex-minister of public works. They are a fair sample of our distinguished men. Now that you may know that we are not all distinguished over the line, he has brought me along. I may also add I am acting in the capacity of chaplain to your worthy ex-president.

I have been announced to speak on the question of "Internationalism," a question which I know you are all interested in in a practical way, for it is your work to build and maintain these great steel highways that bind people together. The highways of a nation make possible a common interest and a community of life in the nation. They conquer sectionalism and provincialism as nothing else can, and in the great world movement of bringing the nations of the world closer together, of integrating them into a greater solidarity of life, the railways must play an important part. Without them the thing is impossible.

In both Canada and the United States we have abundant evidence of the work that railways can do in bringing people together with a real community of life. In the United States at the beginning of your history you were a string of states along the Atlantic coast. The great highway between them was the sea. That natural highway made possible that intermingling of life and interest which is the ground of national life. The history of the development of the American nation has been the history of her railways. From a fringe of small communities along the seaboard, you have grown to almost a hundred million, stretching from the Atlantic to the Pacific, and from Mexico on the south to the Land of Promise in the north. Of course, your railways opened up the country to settlers. But I rather suspect they would have come anyway though not in such great numbers. Even if you had not had railways, the people of Europe would have been drawn by your rich lands and free institutions as by a great world magnet. Instead of the railroad train, the prairie schooner would have carried the people westward. But how would you have preserved the Union? The interests of communities, such as California and New England, Texas and Dakota, without communication, would inevitably have grown apart. I am afraid the "just consent of the governed" would not have been maintained. But the railways bound these diverse states together in a community of life and interest. They are the arteries through which the life of a nation pulsates back and forth. Such free inter-communication of different communities standardizes life and inter-relates interests. If your union is one and indissoluble, it is because your railways have made a real solidarity of life possible. Even the work of Lincoln could not have insured its perpetuity had it not been for the great builders of highways who have laid 200,000 miles of railway since his day.

REV. R. W. DICKIE.



GEORGE A. POST.

What the railways have done for the nation on the south of the line they have done for the nation on the north. We date our national history in Canada from the year 1867, which we call the year of confederation. Before that date there had been in Canada a number of Canadian provinces or colonies, as they were then called, each independent of the other, under the British Crown. They got together and after a while they got the British North America Act, the charter of our nation, establishing a Federal government for the Dominion. But we could not make a nation out of these isolated communities by act of Parliament and royal charter. The great desideratum was to get the life and interests of these communities mixed up. So one of the first acts of the government of the Dominion was to build the Intercolonial Railroad, connecting Ontario and Quebec with the Maritime Provinces. The road has never paid its way in cash earnings, but it has done better—it has mixed the life of Ontario and Quebec with the life of the Maritime Provinches. And then we got wise to the fact that these provinces were but a fraction of our great country. We commenced to realize that we had an immensely extensive and immensely rich country on our western plains, to which

people were already going, and also the Province of British Columbia on the Pacific Coast. Then the Canadian Pacific Railway was projected—one of the greatest railway enterprises ever undertaken, if you remember the difficulties of the task and the fact that then Canada only had 5,000,000 people. Unlike the Intercolonial, it has paid fairly good dividends on its investment, but it, too, has made a united Canada possible. It bound together this string of communities stretching across a continent and made them one people. Two other transcontinental railways will soon be helping in the great work of mixing Canadian life and standardizing it throughout the length and breadth of the land. In Canada we honor the Fathers of Confederation who drew up the plan and constitution of the nation, but we honor not one whit less our railway engineers, these builders of highways which have become the arteries of our national life.

Now, sir, we are two nations on this continent—two independent nations. We in Canada are bound to Britain by many ties—ties of blood, of affection, of interest which we all want to see maintained. This solidarity of interest and affection we designate by that high-sounding word, "imperialism"—a sort of a charmed word with us these days. But Canada has long since got past the stage of a colony or a vassal state. We have absolute control of our own domestic affairs. Another charmed word with us is "national autonomy," and we have the reality. Britain has not meddled in our domestic affairs since confederation. We have power to make commercial treaties with other nations—we were going to make one with you two years ago—and it was not Britain that upset our apple cart, but it was from another source that the trick of jolting the cart was done, that furthered the upset. A few years ago we made a commercial treaty with France. Well, with our internal affairs in our own hands and our foreign relations, there we have the substance of our independence, if not the name. But what of the power of the crown? We own the same thing as Britain does, just as Scotland did before the union. But our King has not a tithe of the power of your President. He is a constitutional monarch, who acts only on the advice of ministers directly responsible to the people. To all intents and purposes the nation to the north is as independent as the republic to the south.

Like you, too, we in Canada are very proud of our country and its institutions. We have unbounded confidence in the future of our country. We are but a small people yet—only about eight millions—but we believe that our great national wealth will bring the peoples. That wheat field of ours in itself—900 miles by 300 miles in area—will bring people, to say nothing of the wealth of forest and mine, and we have a larger potential water power than any other country—about twice that of the United States—and the people are coming to us just as fast as we want them—as fast as we can assimilate them into our national life. As it is, in proportion to our population, they are coming faster than they ever came to your shores. Last year we received over 350,000, 75 per cent English-speaking and 25 per cent foreign-speaking. You sent us about the same number as Great Britain. Send us more. These men from the Middle West states are the equal of the best that we get in our west. There are some timid souls among us who fear what they call the American invasion of our west. I am not at all afraid of it; I will trust the average American citizen to be loyal to the institutions of the land where he is making money, and I am glad to say most of them are making money out on our plains.

And we are proud of our institutions.

Your republic has been spoken of as the great experiment in democracy. You are past the experimental stage long since and have abundantly justified the experiment. But we, too, are making an experiment in democracy, and we hope to profit by your great experiment. We are laying the foundations of our national life under the most favorable circumstances. We are comparatively unhampered by old-world traditions and we learn both from America and Europe. In a word, our experiment in the Canadian democracy is to secure the freedom of a republic and the stability of a monarchy, and up to date I think we are succeeding.

Gentlemen, we are two peoples on this continent. Our histories, our traditions, our institutions are not the same. The destinies of the two are not yet manifest. But one thing is certain, annexation is out of the question. The thing is as dead as a door nail. So far as I know, there are only two annexationists on this continent. One in the United States and one in the Province of Quebec. But, honestly, I think he of the United States was only joking, and I believe the Province of Quebec man has recently gone back on the idea. Goldwin Smith, Erastus Wiman and Elgin Myers and Edward Farrar have no successors and we might as well give the thing a decent burial.

Two nations, but two nations at peace as brethren laboring for the advancement of civilization on this continent and in the world, is our ideal. The signs are favorable. Next to the loyalty of our two countries to their respective traditions and institutions, I admire their international relations. Three thousand miles without a gun or fort or soldier—that is splendid. Next year we are taking steps to celebrate one hundred years of peace. That, too, is splendid. Let us make it a thousand. I contrast this with the unfortunate conditions obtaining among the European nations. How different the boundary between France and Germany and that between us. Guns, fortresses, marching men everywhere there; here on either side of our unguarded boundaries citizens plying the useful arts of peace, each so busy with his own tasks that he has no time or inclination to prepare for the brutal trial by combat.

Our happy international relations on this continent are due, I think, chiefly to two things. First, we have no old scores to wipe out. We have a hundred years of peace behind us. That is our international tradition. And then both belong to the industrial type of civilization. Herbert Spencer used to say that we move naturally in the course of social evolution from a military to an industrial type of society. We in these two countries have, I think, gone further than the European countries. At any rate, the military temper is not so strong among us. I know that you have the school of General Homor Lea in the states that are always expecting some terrible power to drop down upon your country with destruction, and hysterically calling for more military and naval preparation. We have some of the same kind in Canada—military jingoes, we call them over there. But the men do not represent the genius of either Canada or the United States. Our genius here is to attend to business and play fair and believe that industry and fair play don't need big guns and dreadnoughts to back them up.

If we are to extend this hundred years of peace to a thousand, the railways and the railway builders must play an important part. I have said the railways are the arteries of the great social fabrics. They have bound the states together, and they have bound the Canadian provinces together. Let them continue the great work of social integration and bind together these two nations with bands of steel. Let them run north and south, as well as east and west. These highways of the people have mixed up life from east to west; let them mix it up from north to south. There is no reason why the life of Ontario should not mix as freely with the life of Michigan as with the life of Quebec, or why the life of Manitoba should not mix as freely with the life of Dakota as with Saskatchewan. We are of one stock; we breathe the same American air; our traditions are largely the same. There is no reason why we should stand apart. The mixing of life and interest among our people makes for peace. These 130,000 men you sent over to our plains last year are a pledge of good feeling, and so are the 75,000 Canadians living in Chicago. Every business connection between the two binds us closer together.

It is a great blessing to have a boundary line without a gun. The only thing we have on these boundaries is tariff walls. They are great hindrances to the mixing of life and interest. But, happily, we seem to have seen the worst of them. I do not hear any voices crying to build them higher, and I hear from both sides of the border a cry rising in volume and strength each year to have them lowered. Of course, an economic life which has been nourished behind tariff walls cannot at once throw them down without serious complications. But the encouraging thing is that both peoples are looking that way. Then again your interest is our interest, and our interest is your interest. Even tariff walls can not keep the prosperity of one country from being felt by the other or hold back the hard times of one country from stalking forth into the other. You want things that we have, and we want things that you have. Why should not the exchange of them be without let or hindrance?

You are road builders, and roads are for the freest and easiest possible communication. If you are to build roads north and south and integrate these nations as you have these states with a real solidarity of life, more important for your purposes than tunneling the St. Clair river or spanning the Niagara, is the lowering, and eventually the destruction, of these tariff walls which are separating into two parts an economic life which naturally is one and indivisible. I have no desire to go beyond the hundred mark, yet I hope to see the day when not only shall there be no warships on our lakes, but no tariff walls on our boundaries, when the life of these two peoples shall move freely back and forth over the great highways which you and your successors shall construct.

Gentlemen, we are two separate nations, but we are sprung of the same stock. Your interests are our interests, and our interests are your interests. Carry on your noble work of

making railways and highways, breaking down the spirit of provincialism and sectionalism, integrating these two nations into a greater solidarity of life and interest, until we become among the nations of the earth an example of international common sense and good will.

Mr. Post on "The Effect of Music Upon the Railways."

Does anyone doubt that there has been "music in the air" surrounding our railroads for the past several years? If our railway officials have not for a long time been pupils in the music which portrays public emotion, it would be difficult to understand what they have been doing. But there is not any doubt about it, and they have been apt pupils, too. They know the difference between a solo and a chorus. They have heard them. And the way they have been waltzed around by legislative "Willies" until they were out of breath and dizzy, has been a caution.

Our railways have become practiced listeners to the orchestration of popular desire. Before the regulatory conservatory of music was opened it might be truly said that apparently railway men did not know one note from another. But they do now. Their ears have become skilled to discern whether the theme is dignified or important or trivial. They have become honest and earnest listeners. They can now quickly perceive the skill of the performer in building up an orchestra ao convey to the public the idea of a wrathful composer. They appreciate how effectively the feelings of the public may be played upon when the composer of the theme has recognized the force of the law of "distribution of repetition." The master musician knows that the subject matter of a movement must be repeated again and again in order that it may be firmly fixed in the mind. That is why so many composers of anti-railway movements constantly play up the "wrongs" they want made right, paying no attention to the magnificent line of "rights" that are observed by the railways and which the public really enjoy. In a movement dedicated to woe there is no room for the rapturous note of joy.

The music of railway regulation may be said to be both classic and romantic. The classic has come from the soul of the public in deep tones, registering the fiat of the people that wrongs in morals and equities must be righted The romantic has not been so lofty in impulse, but querulous as to details. The romantic is aimed at the intensity of passion rather than the depths of emotion.

There has been in the composition of regulatory music a strong tracing of the fine Italian hand, if we can depend upon musical writers who tell us that "Italian composers were given to resorting to the easy processes of tickling the ear without regard to the fitting of the melody to the text." There certainly has been a great deal of "ear tickling" done in the scheme of regulation.

It must be admitted in fairness that a very large proportion of the regulatory music to which our railways have listened has adhered closely to the fundamental requisites of proper musical form, as it has contained propositions of themes suitable for development. Chief among these has been the idea of the establishment of railway commissions. As a matter of fact, the railways have become so accustomed to this movement by its frequent repetition that they have entirely overcome their original aversion for it and have come to enjoy many of its harmonic advantages. It is true that they still cannot be said to be enraptured of the drum beats and loud trumpets, which suggest war, and to which they are forced to march, not as volunteers, but as conscripts. But they are marching right along and they keep step with remarkable precision, considering that they were so recently members of the awkward squad. Besides, the histories of the world's wars tell us that many a conscript became a valuable soldier and won encomiums as a patriot.

We all of us know when at the theater a tune is played and words are sung by a masterful singer, we unconsciously begin to hum the tune and then to softly whistle it, and finally when we have packed the words into our memory, we burst forth and sing it ourselves. Well, that is just what has happened to our railway managers. They are now humming the tune of railway regulation. There are some of the notes that bother them because they are so fearfully high in register as to strain their throats; some that are so syncopated that they cause them to stumble, while some of the bass notes are so low that in their efforts to reach them they make a noise like a grouch. There are staccato measures so abrupt, detached and disconnected as to cause them bewilderment in keeping to the tune. Regulatory composition ought to be made more simple for universal rendition, and it is hoped that the theme will be simplified by wise composers who will see that the interpolated bars and movements that really impair the harmony and are not truly germaine to the general theme, are useless and confusing and ought to be cut out.

One of the most important requisites of musical form has been utterly neglected by the composers of regulatory music, and that is the interpolation of needed points of repose. There is too much of the clarion blast of the reveille; the waves of tumultuous fervor lash too high and continuously and the delirium of power is too rampant. There is too little of the sweetened accents of peace as delineated by the flute; not enough of the nerve quieting legato during which the railroads can take their bearings, find out where they are, and what they can do about it, and whether they understand the motif of the composer.

People cannot stand it to be worked up to the pitch of frenzy all the time. The loud pedal was not intended for constant use. There is nothing so exhaustive and wearisome as the continuous exhibition of sheer power.

I was deeply impressed a few nights since by an incident that occurred in a theater in New York. The bill of the play had provided a series of performances varied in scope. Thrilling feats by acrobats caused the audience to be breathless in amazement at the terrible risks of life and limb taken by the performers and elicited salvos of applause as in safety they concluded their perilous undertakings. Prima donnas electrified their hearers by touching high notes that seemed beyond the reach of human throat. Giants with a muscular development super-human gave startling exhibition of what strength can endure and accomplish. Magicians mystified by their legerdemain and won our resounding plaudits. Comedians convulsed us with their drollery. But it was not until a couple who were billed as man and wife, who must live together day after day, gave a skit in which connubial felicity was the keynote, that the audience rose to its highest point of enthusiasm. The voices of the couple were not remarkable, but they sang of love. Their actions were those of intense mutual admiration and their asseverations were that they could not live without each other. They embraced with an ardor that was infectious, and, as they billed and cooed and hugged and kissed with sympathetic unction and sincerity, with the air of those who were thoroughly enjoying themselves and meant every word they were singing, the audience seemingly forgot that they were simply doing a theatrical turn and simply went wild over them. Compared with their appeal to the heart side of the people there assembled all the tricks, skill, daring, fun and art of those who had preceded them was as nothing. All the world loves a lover. The world is at its best when manifesting appreciation, consideration and tenderness. The sweetest, most inspiring, most ennobling music of all the ages is the harmony of the heart.

Within the proper limitations of an after-dinner speech I cannot do more than warble a few notes of all the emotions that well up from my heart to my lips as I am stirred by the contemplation of the effects of harmony when it shall resound throughout the corridors of human endeavor.

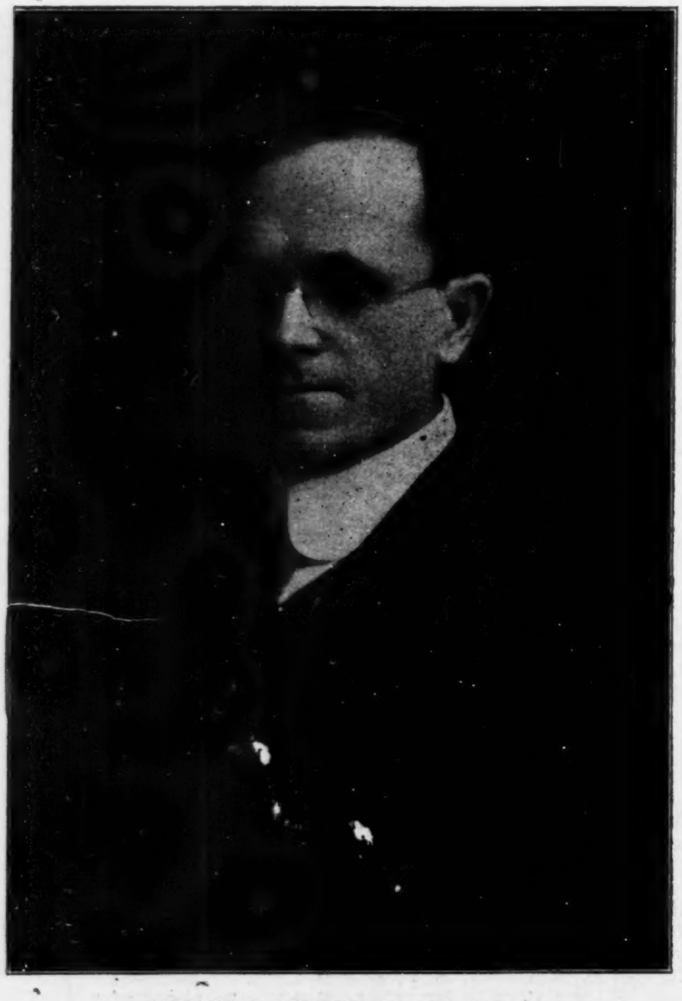
I have touched lightly, and I fear not impressively, upon the effect that the music of regulation has had upon our railways. With all its false notes, strident bars, crashing of brass and impulses of unrestrained fervor, the railways are better for it, and they have learned to make responses thereto —hesitatingly at first—but increasing in strength and in appreciation of its underlying motive.

The point I wish to make by my incursion into the field of musical metaphor is that, having realized how they have been impressed by the concert of the public voice making clear to them the emotions of those who have composed the statutory measures, conceived the movements that have carried conviction of the necessity for governmental supervision of railway operation, the railway managers have shown a disposition to bestir themselves to compose the "music of the rails." Many of our railway executives are appearing in public and upon social occasions to tell the story of the railroads. This is what must be done, and done continuously and effectively. Those who have sung of what they **want** have had too much of a monopoly of the stage center. It is up to the railroad men to sing to them of what they **have**. The railway managers have been too long the audience and it behooves them to become performers themselves. Those who do not exercise their vocal chords by framing language are seldom understood. True, there is a lot of talk that nobody can understand, and that perhaps does not mean much, if anything, but the fact remains that it is the fellow who talks who gets an audience. Some who hear him think they understand and act accordingly. There must be borne home to the consciousness of the public the story of the wonderful things that railroads are doing for them. Place in juxtaposition the blessings that railroads confer upon our land and what the public wants them to do in addition, and the blessings are as a mountain of joy overshadowing a molehill of discontent.

Once get the people of the United States to cease brooding

over their few real ills and many imaginary ones and hold up to them (they cannot be exaggerated) their manifold advantages vouchsafed by their marvelously equipped and managed transportation facilities; show them by your daily walk, conversation and achievements that their real ills are the subject of your serious thought for their proper remedy, and their frowns will be changed to smiles; their imprecations will be changed to words of praise.

So I say to you, my friends of the railways, SING! Sing to the public of mountains tunneled to reduce grades and distances. Sing to them of the waters spanned by steel and of embankments upheld by granite eternal. Sing of the luxury of modern travel and of the sleepless vigils kept for the safety of those who must absent themselves from their home firesides. Sing of the annihilation of distance by the celerity of train movement. Sing of the spacious and majestic terminals in our great cities, with every heed for their creature comfort and convenience. Sing of the doubling and quadrupling of tracks for the handling of our nation's traffic.



EDWIN F. WENDT, President-Elect.

Sing of the higher wages and lower rates of American railroads when compared with other countries. Sing to the populace of your comprehension of their needs, and when from the choir of the people you hear the prayer, "Oh, Promise Me!" in answering song tell them that the vow is made and will be kept.

Thus shall we as a people move steadily up the mountainside which leads to the great Plain of Amity, where athwart the vaulted heaven above shall be displayed in letters of living light the memorable words of Grant, "Let us have peace."

Then as the multitude of those who must be served by the railways approach the hosts of those who serve them, who are moving with radiant faces to meet them, the air will be vibrant with a song from the people:

"Our railroads are our joy and pride;
No more their conduct we deride.
We're boastful of their usefulness,
And they our rights do not transgress."

And with a zest, bespeaking a glee that maketh the heart glad, shall come the response from those who carry:

"See, our patrons, an army great,
Our service they appreciate!
Our dealings square, from wrath we're clear,
And they are now our friends sincere."

Having come within close touch, when hands may be clasped in cordial grip, in splendid unison, making the welkin ring with the melody of friendship, all will join in singing:

"Together we, in harmony,
Will weave our country's destiny,
In field and mart, in mine and mill,
And, on the rails, there'll be good will."

NEW OFFICERS OF THE A. R. E. A.

The result of the election of officers of the American Railway Engineering Association for the ensuing year was announced by President Churchill just before the close of the afternoon session yesterday. The new officers are:

President—E. F. Wendt, assistant engineer, Pittsburgh & Lake Erie, Pittsburgh, Pa.

First Vice-President—W. B. Storey, Jr., vice-president, Santa Fe System, Chicago, Ill.

Second Vice-President—Robt. Trimble, chief engineer maintenance of way, Northwest System, Pennsylvania Lines, Pittsburgh, Pa.

Treasurer—Geo. H. Bremner, engineer Illinois District, Chicago, Burlington & Quincy, Chicago, Ill.

Secretary—E. H. Fritch.

Directors for Three Years—

A. K. Shurtleff, office engineer, Chicago, Rock Island & Pacific, Chicago, Ill.

C. A. Morse, chief engineer, Santa Fe System, Topeka, Kans.

John G. Sullivan, chief engineer, Western Lines, Canadian Pacific, Winnipeg, Man.

Members of the Nominating Committee—

H. R. Safford, chief engineer, Grand Trunk System, Montreal, Que.

A. O. Cunningham, chief engineer, Wabash, St. Louis, Mo.

R. L. Huntley, chief engineer, Union Pacific, Omaha, Neb.

R. N. Begien, assistant general superintendent, Baltimore & Ohio, Baltimore, Md.

A. F. Robinson, bridge engineer, Santa Fe System, Chicago, Ill.

REGISTRATION—AMERICAN RAILWAY ENGINEERING ASSOCIATION.

MEMBERS.

Alfred, F. H., Gen. Man., P. M. R. R., Detroit, Mich.
Bailey, A. R., Instructor Surveying, Univ. of Mich., Ann Arbor, Mich.
Barnard, R. C., Supt., Pennsylvania Lines, Cincinnati, O.
Batchellor, F. D., Asst. to Gen. Supt., B. & O. S. W. R. R., Cincinnati.
Bates, Onward, Con. Eng., Chicago.
Beahan, Willard, Assistant Engineer, L. S. & M. S. Ry., Cleveland.
Beye, John C., Loc. Eng., C., R. I. & P. Ry., Chicago, Ill.
Bisbee, F. M., Engineer W. L., Santa Fe Railway, La Junta, Colo.
Bohland, J. A., Bridge Engineer, G. N. Ry., St. Paul, Minn.
Boyd, G. E., Supt. B. and B., D. L. & W. R. A., Scranton, Pa.
Brown, A. V., Engineer. M. W., Lake Shore Electric Ry., Sandusky, Ohio.
Brown, E. T., Div. Eng., B. & O. R. R., Grafton, W. Va.
Brown, H. W., Asst. Div. Eng., Pennsylvania Lines, Logansport, Ind.
Brumley, D. J., Eng. Const., I. C. R. R., Chicago, Ill.
Budd, Ralph, Ch. Eng., G. N. Ry., St. Paul, Minn.
Burke, James, E. M. W., Erie R. R., Cleveland, O.
Byers, M. C., Asst. to Prest., G. N. Ry., St. Paul, Minn.
Chandler, Charles, Bridge Engineer, C. G. W. R. R., Chicago, Ill.
Cleveland, G. C., Ch. Eng., L. S. & M. S. Ry., Cleveland, O.

Condron, T. L., Consulting Engineer, Monadnock Block, Chicago.
Coon, C. J., Eng., Grand Cent. Ter., N. Y. C. & H. R. R., New York.
Cowper, J. W., Vice-Prest., Lack. Br. Co., New York.
Cronican, W. P., Asst. Eng., Illinois Central R. R., Chicago, Ill.
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SUPERVISORS AT THE CONVENTION.

The Bessemer & Lake Erie is well represented at the convention and the exhibition. All five of this company's track supervisors and both of its supervisors of structures are spending two days each in the sessions of the convention and at the Coliseum.

The three supervisors of the St. Louis division of the Vandalia are visiting the convention and the exhibition to-day.

APPLICATION OF B. & O. DYNAMOMETER TESTS TO TONNAGE RATING.*

By R. N. Begien,
Assistant General Superintendent, Baltimore & Ohio.

Many miles have been run with dynamometer cars, but few real results have been obtained which give reliable data concerning train resistance. The number of formulæ in use only serves to inspire a serious doubt as to the accuracy of any of them. It is true that some dynamometer charts have not been properly studied, but there are many unknown factors which make the interpretation of the charts difficult. Facilities for making these tests properly are rarely had. It is an expensive matter to make the tests and an equally expensive one to analyze the charts. The results obtained seldom agree with the preconceived notions of those who use them, causing modifications and amplifications of a more or less "practical" nature. The verdict is, generally, that the only way to make a rating is to try different loadings until the correct one is found, and then use it.

This method would be all right if the loading adopted as the result of such trials was a proper one for all conditions of cars and condition of track and weather. There is also a difference of opinion as to what constitutes a correct rating. It is a mistake to suppose that proper ratings depend entirely on the power of the locomotive and the grade; yet the ideal condition is realized when such facilities for handling trains are supplied that those two factors control the rating. The tests described below have demonstrated that with the wide variation of working conditions on a railroad, there is no such thing as an absolute value to train resistance. It is, however, possible to establish a practical base which is on the safe side and will give good working results. Since the object of tonnage rating is to establish a standard by which performance may be measured, it is better to predetermine that standard than to allow each one to make its own. The inevitable result of the establishment of standards is good, since uniformity of performance approximating a proper standard always yields a higher average than a mixture of high and low grade performance. In other words, good results may be obtained by doing well all the time.

DYNAMOMETER TESTS.

During the months of October, November and December, 1910, and January, 1911, dynamometer tests were made on the Baltimore & Ohio, with trains made up as naturally resulted from traffic conditions. The tests extended over all the main lines and more important branches of the road, thus embracing a wide variety of conditions. The profiles of many of the divisions were specially run for these tests. The dynamometer used was of the direct pull oil cylinder type, with piston rod connected to the drawbar of the car. The recording apparatus of the car was described in the *Railway Age* of April 13, 1906, page 655.

Graphical charts were made by the recording apparatus showing continuous records of the following items of information: (a) Location of the test car upon the road; (b) time elapsed since beginning of test (½-min. intervals); (c) mile posts; (d) speed in miles per hour; (e) drawbar pull of locomotive; (f) injector in use or shut-off; (g) coal fired (number of scoops); (h) boiler pressure; (i) train line (air) pressure. Notations of temperature and weather conditions were made as often as change occurred. Data of train consist, weight and length were entered on the charts. On the engine, "log books" were kept preserving tabulated records of: Position of reversing lever, position of throttle lever, use of injector, boiler pressure, scoops of coal fired, water consumed, and other data relating to the tests.

CALCULATING RESULTS.

The purpose of the calculation was to determine the total frictional train resistance at intervals of one-half minute throughout each test run. To do this, it was necessary to calculate the resistances due to grade, curvature and acceleration at each half-minute interval, and to subtract the sum of these resistances at each such point from the total drawbar pull developed by the engine at that point. The remainder, being the total frictional train resistance, was divided by the weight of the train in tons, thus obtaining the frictional train resistance in pounds per ton. This method gives the momentary values of "train resistance" at the points considered.

The speed of the paper travel used on the recording machine throughout the tests was such as to make the graphical charts on a scale of three inches to the mile. A distinctive mark on the time record line shown on the charts was made to indicate the expiration of each half-minute interval. The points so indicated will hereinafter be spoken of as "half-minute points." It was necessary to determine for each half-minute point the speed of the train, the difference in feet of elevation between the rear of the tender and the rear of the caboose, and the degree of curvature of the section of track on which the train was located at that instant.

To determine the speed at each half-minute point, the average speed during the half-minute interval preceding was added to the average speed during the half-minute interval succeeding and the sum having been divided by two, the result was considered as the speed at the point under consideration.

The average speed during each half-minute interval was determined as follows: Through each half-minute point a vertical line was drawn, cutting the drawbar pull record line, the distance record line and the location record line. Having selected on the chart some well-established point such as a signal tower, it was given the mileage designation corresponding to its mileage on the track profile. The distance from this point to each half-minute interval was scaled and the resulting mileage figure assigned. This mileage was then reduced to terms of hundred foot stations, corresponding to the stations on the track profile by multiplying by 52.8. The difference between the mileage figures at two adjacent half-minute points multiplied by 120 was then the average speed for the interval between these points. This speed was checked by scaling between the half-minute points with a 40 parts to the inch scale, reading one "mile per hour" for each 1/40 inch.

The calculations were tabulated in columns headed, "Time"; "Miles from Starting"; "Hundred Foot Stations"; "Grade Factor" (i. e., difference in feet of elevation between rear of tender and rear of caboose); "Speed"; "Speed Difference" (i. e., increase in speed during the half-minute interval); "Speed Force" (i. e., pounds of available drawbar pull consumed in acceleration); "Grade Force" (i. e., pounds of available drawbar pull consumed in overcoming the resistance due to grade and curvature), and "Speed Force plus Grade Force" (i. e., the sum of the two items next preceding and the total amount to be subtracted from total drawbar pull, leaving as remainder total "Train Resistance"). The "Speed Difference" was deduced from the "Speeds" by subtraction, and shows the average acceleration in miles per hour for half-minute intervals. The "Speed Force" was obtained by use of the formula giv n by G. R. Henderson, in his "Locomotive Operation:"

(1) $Pt = C\dfrac{V_2^2 - V_1^2}{S}$, where Pt = energy in lbs. per ton. C = constant. V_1 = and V_2 = velocities considered in miles

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*Abstract of Appendix B to the Report of the Committee on Economics of Railway Location.

per hour. S = distance in feet. For a constant time interval of 30 seconds.

$$(2)\quad S = \frac{5280}{120}\,\frac{V_2 + V_1}{2} = 22\ (V_2 + V_1) = \text{feet per half minute.}$$

Substituting (2) in (1).

$$Pt = \frac{C\,(V_2^2 - V_1^2)}{22\,(V_2 + V_1)} = \frac{C}{22}\,(V_2 - V_1).$$

The revolving wheels tend to increase the effective inertia in a horizontal direction in a loaded car by three per cent., and in an empty car by eight per cent.

Applying these percentages to 66.76 (given by Henderson):

$C = 1.03 \times 66.76 = 68.76$ for loaded cars.
$C = 1.03 \times 66.76 = 68.65$ for loaded cars.

$$\text{Then } Pt = \frac{68.65}{22}\,(V_2 - V_1) = 3.12\ (V_2 - V_1) \text{ for loaded cars.}$$

$$= \frac{72.1}{22}\,(V_2 - V_1) = 3.28\ (V_2 - V_1) \text{ for empty cars.}$$

$$= 3.20\ (V_2 - V_1) \text{ for partly loaded.}$$

The total force of acceleration for a train, for an interval of 30 seconds, is:

$$P = KT\ (V_2 - V_1),$$

when P = total force of acceleration (+ when speed is increasing, and — when decreasing).
K = constant varying from 3.12 to 3.28 as above.
T = actual tonnage of train behind tender.
$V_2 - V_1$ = change of velocity in miles per hour.

$V_2 - V_1$ was taken to the nearest tenth mile and tables prepared for each train consist to show P for any change of velocity appearing in the speed difference column.

The "Grade Factor" was scaled from the profile and shows the difference in elevation in feet between the rear of the tender and the rear of the caboose at the half-minute point, the length of the train having been computed from the train consist, and laid down to scale on the track profile, according to the position of the head end of train, shown in the "Station" column. A (+) "Grade Factor" indicates an ascending grade, and a (—) "Grade Factor" indicates a descending grade in the direction in which the train is moving.

Curvature was allowed for in the "Grade Factor" by adding a (+) quantity to the difference in elevation between the ends of the train, at the rate of .04 ft. for each degree of central angle occupied by the train for curves of over 1,000 ft. in length, and shorter curves when the tangent track between them was so small that the train may be taken to be entirely on curve. For curves less than 1,000 ft. in length, the compensation was taken at .03 ft. per degree of central angle.

The force consumed in overcoming the resistance due to grade and curvature is:

$$F^1 = \frac{G \times 20}{L},$$ where F = force in lbs. per ton (+ when grade is ascending, and — when descending). G = "Grade Factor" in feet. L = length of train behind tender expressed in "Stations" (units of 100 feet).

$$F^1 = T\,\frac{G \times 20}{L} = \text{Total "Grade Force" for train of (T) tons (L) 100-ft. stations in length.}$$

$T\dfrac{20}{L}$ — is a constant for each train consist and F was tabulated for different values of G to tenths of a foot.

"Speed Force + Grade Force" at each half-minute point was subtracted from the drawbar pull shown on the chart at that point, leaving as remainder the total train resistance, which divided by the total tonnage of the train gave the momentary resistance in pounds per ton at that point.

Record books were used to preserve a tabulated record of the half-minute readings for each run, classifying the readings by speed ranges (1-5, 5-10, 10-15, 15-20, 20-30, 30-40 and 40-50 miles per hour), temperature ranges (20 to 35 deg. and 35 deg. up) and ranges of car weight (below 20, 20 to 30, 30 to 40, 40 to 50, 50 to 60, 60 to 70, and over 70 tons). A chart was made for each run, plotting "resistance" and "time" vertically against "distance from start" horizontally. The legend showed "average car weight," "temperature ranges" and "speed ranges" and for each point plotted a note was made of the number of half-minute readings averaged to give the value plotted. Each value plotted was the average of ten or less half-minute readings. From the "run charts" were selected all stops of sufficient length to cause an increase of 3 lbs. per ton in resistance, the increase in resistance caused by a stop being determined by averaging all half-minute readings for 15 minutes before the stop and subtracting from the average of all half-minute readings for 15 minutes after the stop. These selected stops were plotted on the charts as "zero distance." Resistance was plotted vertically against "distance from stop" horizontally. For each R value plotted, the number of half-minute readings averaged to secure the value was indicated.

The "final charts" were obtained by classifying the "stop charts" by "average car weight" and "temperature range" groups. The points on charts which could be so classified into one group were replotted into a series of charts varying from each other only in the "speed range" covered by each. A curve was then drawn on each chart so classified and replotted, which indicated the "resistance" value for that particular "average car weight," "temperature range" and "speed range."

"Final charts" from fourteen test runs have been worked up according to the preceding outline. These test runs have been grouped into three sets as follows:

Group No. 1.
(Temperature Range, 20 to 35 deg.) (Average Car Weight, 30 to 46 tons.)

	Temperature.	Average Car Weight.	Total Tons.
Run No. 1	32-35 deg.	46 tons	1,693
Run No. 2	33-35 deg.	35.3 tons	954
Run No. 3	29-35 deg.	30.1 tons	1,084
Run No. 4	22-35 deg.	39.0 tons	1,246
Run No. 5	23-35 deg.	33.5 tons	1,071
Run No. 6	31-35 deg.	37.1 tons	1,225
Run No. 7	27-35 deg.	38.6 tons	1,159

Group No. 2.
(Average Car Weight, 10 to 30 tons.) (Temperature Range, (20 to 35 deg.)

	Temperature.	Average Car Weight.	Total Tons.
Run No. 8	26-35 deg.	18.6 tons	874
Run No. 9	27-35 deg.	24.7 tons	839

Group No. 3.
(Average Car Weight, 30 to 50 tons.) (Temperature Range, 20 to 35 deg.)

	Temperature.	Average Car Weight.	Total Tons.
Run No. 10	50-60 deg.	27.6 tons	382
Run No. 11	36-40 deg.	50.7 tons	1,370
Run No. 12	35-38 deg.	35.6 tons	1,244
Run No. 13	48-56 deg.	35.2 tons	914
Run No. 14	35-47 deg.	34.6 tons	1,108

It will be observed that in each of the three groups the range of average car weight, and in Group No. 3 the temperature range, is greater than contemplated in the outline. This modification of the outline was adopted in order to get as many points as possible in each set, from which to draw curves, it having found that if the original outline were strictly adhered to there would not be enough points in each group to indicate any definite results. Even under the modified plan the results are meager, Groups Nos. 2 and 3 not having enough points to give satisfactory indications. Group No. 1 is fairly satisfactory.

Study of the final charts shows that the plotting points fall at widely varying distances above and below the curve of average value, and, while the curve may readily be drawn, there is no close aggregation of points immediately along the curve. Although other investigators have exhibited charts, resulting from studies of similar tests, which do show the points all practically falling on the curves, the conclusion reached in the present instance is that under service conditions the different items entering into train resistance are continually varying through such wide ranges that the total resistance, even under conditions considered constant, cannot be determined to be any very constant quantity. Nor can it be concluded that a curve may be drawn which will represent more than an average of widely varying values.

In the Manual of Recommended Practice of the American Railway Engineering Association is given the adopted formula for train resistance on a level grade: $R = 2.2\ T + 122\ C$. The tests made do not show any results which would change that formula. It is probably as practical as necessary, and will give results which are close enough for service conditions. Absolute accuracy is not essential, since the train resistance must be equated with the engine tractive power, and the latter must have a large factor of safety to make up for the varying capacity of the crew, the differences in fuel and the condition of the machine.

DEVELOPMENT OF FORMULÆ FOR OTHER TEMPERATURES.

Using the charts in Groups Nos. 1 and 2, a formula for resistance in pounds per ton has been derived for "B" rating at temperatures from 20 to 35 deg. Averaging all readings shown at more than 10 miles from start, on charts in Group No. 2, in which the average car weight is 21 tons, gives $R = 9.5$ lbs. per ton. Averaging all readings shown at more than 10 miles from start, on charts in Group No. 1, in which the average car weight is 37 tons, gives $R = 6.7$ lbs. per ton.

In the resistance formula $R = K\ (T) + K'\ (C)$, in which $T =$ tons per car, $C =$ number of cars, and K and K' are constants solve for the value of K, as follows:

21-ton car: $21 \times 9.5 \text{ lbs.} = 199.5 = K\ (21) + K'\ (1)$ (1)

37-ton car: $37 \times 6.7 \text{ lbs.} = 247.9 = K\ (37) + K'\ (1)$ (2)

Substituting (1) from (2), $48.4 = K\ 16$

$$K = 3.0$$

Substituting K in (1) and solving for K',

$$199.5 = 3.0 \times 21 + K'$$

$$K' = 136.5.$$

Substituting these values of K and K' in the resistance formula, $R = 3.0\ T + 136.5\ C.$

Investigations made from data not as good as the preceding have enabled the completion of formulæ for other temperatures. It is arbitrarily assumed that the ratings are called A, B, C and D, as follows: A rating for temperatures over 35 deg. F., B rating for temperatures between 20 and 35 deg. F., C rating for temperatures between 0 and 20 deg. F. and D rating below 0 deg. F. Without going into detail, the formulæ deduced are:

A rating: $R = 2.2\ T + 122\ C.$

B rating: $R = 3.0\ T + 137\ C.$

C rating: $R = 4.0\ T + 153\ C.$

D rating: $R = 5.4\ T + 171\ C.$

Ratings made on the basis of these formulæ have stood the test of practice. They should be used as a basis to work on and should be tempered by the judgment of the operating officer in charge on the ground.

In practice, the drop from A to B is usually made by giving trains A rating minus 50 tons or minus 100 tons, and gradually following the temperature rather than by changing suddenly. It should be understood that decreased ratings are used for other conditions of weather than those caused by temperature, high wind being a frequent cause of reduction. When the frost comes in the fall, its effect begins to show up in increased transportation expense. The slow freights catch it first. For a while an effort is made to hold up the ratings, but the frost gets into the journals and the time of the run drags out until the items "Crews relieved" and "Exceeded 16 hours" cause a cut in the ratings. Fast freights which make almost continuous runs without stops are not much affected by cold weather unless it is very severe. High winds, however, are very hard on both fast freights and passenger trains. The combination of high winds and cold weather should be amply compensated by reduced ratings, as not only is the train resistance increased, but the loss of power on the engine affects its hauling capacity.

It is difficult to always "size up" the conditions a train is going to meet throughout its run so as to give it the proper tonnage. The following items should be considered: Trains leaving terminal in the afternoon will have the lower night temperatures to meet. Trains starting at night under severe cold may often pick up tonnage after the sun is up. Trains starting a run in the low altitudes will find colder weather in the mountains. Trains starting in the mountains may often take on tonnage in the low lands. Trains having many stops and starts will be affected by cold more than trains running continuously. Trains starting up-grade leaving terminal may haul larger ratings if helped leaving terminal for at least 20 minutes until the journals become warmed. Position of passing sidings plays an important part in rating trains in winter. If sidings are in such positions that a train starts out of siding on a down-grade or on a grade substantially less than the ruling grade, larger ratings may be handled than is the case where sidings are located on ruling grades. If trains can get out of terminals promptly and put in the time on the road instead of standing in yards, better rating may be handled than when a large part of the allowable time is consumed in doing nothing.

The temperature has the following effects on expense and on the revenue train load: Increased overtime, increased yard expense, increased enginehouse expense, increased fuel for locomotives and for heating, increased damage to equipment on road, increased snow and ice account, increased other expense, and decreased train load. As the revenue train load decreases, all of the expenses which vary with the train load increase. Since from 25 to 30 per cent of all transportation expense varies directly with the train load (depending on the proportion of the road expense to all expense), it is evident that the effect of temperature is heavy.

Of all the tonnage hauled on a railroad whose train load is above 300 revenue tons, only the slow freight maintains a train load constantly above the average. Manifest trains rarely carry more than 50 cars, and do not average that much. The car load is light—five tons is fair—and 250 revenue tons is a high revenue train load. Local freights make very low train load and haul freight at high expense for wages. They are often back hauls in local freight, which are a loss as far as revenue train load is concerned. The effect of both local freights and fast freights, therefore, is to hold down the revenue train load. Since temperature ratings affect slow freights principally, and fast freights and local freights up to a lesser degree, it is evident that its effect on the revenue train load is quickly apparent.

In Middle Atlantic states the train load will decrease from 15 to 30 per cent. in winter, depending on conditions. When the proportion of heavy slow freight to the total business decreases, the drop in the train load is especially great. On account of cold weather troubles at engine terminals, steam failures on the road, and for other reasons, locomotives make less mileage in winter than in summer. There is always trouble on long grades, where the fireman has to work continuously for more than an hour. Firemen do not like to perspire in the winter and they usually wear more clothes than necessary if they are exerting themselves. The en-

gineer on his seat box is dressed for sitting still and not for helping out a fireman with a dying fire. So a drag engine with a heavy tonnage train often fails in the winter when it would be all right in summer.

The freezing of coal and ore in cars is a cause of great delay to the movement of cars, which often means light trains to get faster movement. The ordinary method of building fires under cars to thaw them out and pounding the hoppers with hammers results in increased expense apart from the delay to the cars. It takes men to build fires under cars and it costs money to furnish fuel to burn. It also takes extra force to beat hoppers.

If cold weather comes at a time when business is brisk, as in the winter of 1911-12, the expense in all departments is bound to be heavy. It pays, therefore, to know something about effect of temperature on train haul. In practice there are two ways of allowing for variations of temperature: (1) Keep the rating constant and vary the adjustment for each temperature, and (2) keep the adjustment constant and vary the rating for each temperature. They both amount to the same thing in determining the actual tons hauled, but in practice it is probably better to follow the second plan. By so doing, train crews readily see that a reduction in tonnage has been made, whereas, if the "Wheel Report" shows full tonnage and merely a change in the adjustment, they often think they are hauling "A" ratings in "C" weather.

The formulæ developed above for B, C and D rating on level grade should be used to represent the resistance of a train that has been in motion at least 15 minutes. It is practical to assume that the resistance will be constant up to 30 miles per hour. With reasonable ratings of the power, starting resistances are negligible in warm weather. The engine must have a greater margin in cold weather, and when starts have to be made on ruling grades (especially when they follow long stops) extra allowance should be made.

TONNAGE RATINGS.

Proper tonnage rating is that load which can be hauled by the engine under consideration over the road at an economical speed. Owing to factors which are, in a measure, indeterminate, it is not an exact science. Strictly economical tonnage rating would be different for every train. This can readily be seen, since no two engines are in the same condition. In a like manner, some cars are in a better condition to be hauled than others. Road conditions differ on different parts of the same division and some men are better and more uniform performers than others. Perfect uniformity of mechanical and roadway conditions would result in large economies in the way of a decreased number of trains due to increased tonnage per train. Where it is impossible to secure perfection, uniformity pays well, even if it costs money to get it.

The object of adjusted tonnage rating is to give an engine the same amount of work to do regardless of whether a train is made up of heavy loads, light loads, empties, or any combination of them. If all cars of the same weight had an equal resistance to traction, this would be possible. Different kinds of cars and varying conditions of track, weather and wind make it possible only to approximate the desired result. The adjustment is an arbitrary amount added to the weight of each car, whether loaded or empty, to qualize the pull on the engine under conditions of hauling loaded, empty or mixed trains. Adjustments are functions of the rate of grade and the resistances of the train. Practically they vary only with the rate of grade.

Most operating divisions have broken profiles and different rates of grade, so that the ruling grade should be first determined, the ruling grade being the grade which governs the train load. The adjustment for that grade should be used. If train loads are adjusted correctly for limiting conditions, there will be no trouble with the other parts of the railroad as far as tractive power is concerned. When helpers are in use, the adjustment should be for the single engine ruling grade. This procedure will establish an adjustment which will be too large for helper grades, but the error is on the safe side.

When possible, the grades should be established from recent profiles. If there are none, it is a good plan to run them. Railroad profiles change in the course of years. It is a well-known fact that fills settle, causing deep sags in the grade line. The raising of tracks through cuts is cheaper than ditching, but is responsible for summits in the cuts. On some lines, where the profile has been checked, it has been found that stretches of 0.3 per cent. grade have become 1 per cent. If places of this character occur near a point of heavy resistance, an immediate effect on the tonnage of a train is the result. When an engine is working with its bar well forward, with the fireman tired out, the fire dirty, and the steam pressure dropping, such places will cause the stalling of a train, and in a short time the frequent delays will result in decreased tonnage rating.

Raising tracks is not as economical as the section foreman and supervisor would lead us to believe. While better drainage is undoubtedly secured, it is generally better practice to clean the ballast, and widen cuts to secure a ditch, and to raise track only when it becomes necessary to put roadbed to a proper line and surface. On such occasions, grade stakes should be used to establish the grades. On many railroads an effort has been made to place permanent monuments, so that the track could be kept at a constant elevation. The difficulty of maintaining monuments along a roadbed is well known. They are likely not only to be a menace to the lives of the trainment, but they are constantly settling, and being knocked by sectionmen, and occasionally by derailments. However, the importance of placing permanent monuments cannot be overestimated.

In the early days of railroading, compensating for curvature was practically unknown. For many years it was probably unnecessary. Compensation for curvature is not vital to small trains running at speed. The resistance due to curvature is principally felt by heavy tonnage trains on ruling grades where the engine is rated at a high percentage of its cylinder tractive power. Various experiments have been made to determine how much reduction in grade would compensate for the added resistance of curvature. It has generally been the practice to compensate this at a stated amount, and, while this method is not as accurate as could be desired, it is very much better than no compensation at all. From considerable obseravtion of the influence of curvature and an examination of numerous tests of its effects, it is felt that the following rules would improve the present practice.

Conclusions: Compensate .03 per degree: When the length of curve is less than half the length of the longest train, when a curve occurs within the first 20 ft. of rise of a grade, or when curvature is in no sense limiting. Compesnate .035 per degree: When curves are between ½ and ¾ as long as the longest train, and when the curve occurs between 20 ft. and 40 ft. of rise from the bottom of the grade. Compesnate .04 per degree: When the curve is habitually operated at low speed, when the length of the curve is longer than ¾ of the length of the longest train, when super-elevation is excessive for freight trains, and at all places where curvature is likely to be limiting. Compensate .05 per degree wherever the loss of elevation can be spared.

The effect of curvature on low grades is generally greater than on heavy grades, provided the length of train is what would be justified by the low grade. In speaking of low grades, levels, 0.1 per cent, 0.2 per cent and 0.3 per cent grades are referred to. On double track railroads, particular attention should be paid to curves, whether uphill, downhill, or level, at places where steam is being taken by the engine in

moving in either direction. On virtual level grades each track should have its tangents slightly raised and its curves slightly sloping down hill, so that the pull by the engine may be uniform, and the resistance of the line constant. The value of keeping the line resistance constant becomes more important as the length of the train increases. One of the prime objections to hauling a long train is the danger of parting, and in this danger curvature plays an important part. If the line is crooked, having many short curves, it is usual for the slack of the train to be constantly taken up and let out. If the engine runs out on a bit of straight track, when the rear of the train is bunched on the curves, it will accelerate faster than the other end of the train. Unless the engineer is watching, and using the brakes slightly, he may pull out a drawbar. If, on the other hand, the front end of the train is on a curve, and the rear end on straight track, the tendency is for the rear end to run in on the front end, and break a knuckle. It should not be supposed that it is impossible to have different classes of compensation on each track of a double track railroad.

From a scientific standpoint, although not always from a financial view, it is evident that a six-track railroad is the most desirable for a road that handles a three-speed service. This will give a passenger track, a fast freight track, and a slow freight track in each direction. Without attempting to discuss what will be gained by the operation of a six-track railroad, it should be said that as many tracks as possible are justified if a standpoint of super-elevation alone is considered. Of course, it becomes necessary for a train to stop occasionally on a curve, and for that particular case the super-elevation is always wrong. Inasmuch as no super-elevation at all is necessary at very low speeds, it may be eliminated entirely on tracks that are used exclusively for standing cars, and very low super-elevation, if any, should be used for yard tracks.

On a single-track railroad carrying more than one class of traffic, there are two ways to treat super-elevation: (1) Make the freight tonnage rating as great as possible, and in accordance with the ruling grade. In this case, it will be necessary to elevate the curves for freight speed, and run the passenger trains slowly over ruling grades. (2) Use a higher super-elevation for passenger speeds, and decrease the tonnage rating to make up for the increased resistance caused by the wheels of the freight trains binding against the lower rail.

Single-track railroads which are crooked can rarely haul as high a percentage of rating as double-track railroads, on account of the super-elevation being wrong. It is easy to see that every down-grade becomes an up-grade for movements in the opposite direction on a single-track road. Inasmuch as the movement downhill is likely to be faster than it is uphill, the super-elevation must be made for the downhill movement or introduce speed limits on downhill trains. On single lines that are exclusively for freight, super-elevation on ruling grades should be made for not over 15 miles per hour. It is less expensive to slow down the descending movement than to reduce tonnage rating on account of excessive super-elevation.

Without discussing the theory of the spiral as affecting railway grades, it should be said that the object of the spiral is twofold: To afford a run-off and a run-on from a level cross-section to a super-elevation cross-section, and to ease the horizontal passage from a straight line to a curve. It is evident that in passing from a level position to a super-elevated position, when the inner rail of the curve is laid at grade, the center of gravity of the mass of the train must be raised through a distance equal to one-half the super-elevation. This is generally a minor rise, but in order to haul uniform tonnage this minor point should be carefully observed, especially where limiting conditions are found, such as places near the end of a long-continued effort. It has been proposed in the past that the inner rail be depressed a distance equal to one-half of the super-elevation, and the outer rail be raised the same amount. While this has been objected to by some railroad men, it can certainly be done and so maintained, and from a tonnage standpoint it is desirable. It is submitted that the railway of the future, which is scientifically operated, will find conditions such as these limiting their tonnage unless care is taken. While it might be said that refinements in the track are unimportant, it should be borne in mind that, in order to realize the full value of improvements, these matters must be taken into consideration. A combination of correct conditions results in the most effective operation.

Curves that reverse without any tangent between them mean operating expense. Not only must the super-elevation change abruptly, but the trucks must change their position in the same manner. It is considered good practice to leave room between the points of spiral for four freight cars to straighten up after they change direction. On most new construction, provision is made for at least 1,000 ft. between curves, and this practice is recommended unless great expense is involved.

In exactly the same way that a horse can haul a wagon better on an asphalt pavement than on a cobble stone road, so can a locomotive haul tonnage more easily on a good track than on a poor track. Without going very far into the discussion of track maintenance, it may be stated that from a tonnage standpoint good track consists of the following things: Mathematical alinement, super-elevation conforming to the speed, an unyielding sub-grade, heavy enough rail so that the depression under the ruling grade is small, enough ties beneath the rail to transmit the load uniformly to the sub-grade, deep enough ballast to secure good drainage and distribution of loading, and as much strength as is necessary. It is easy to see that if a train is hauled along a roadway that is constantly pressing down the rails, it is literally climbing a hill all the time.

Many railroads are suffering today on account of the fact that during the early days of construction it was not thoroughly realized that a tunnel might be a limiting factor in tonnage rating. The following are the causes of the limiting effect of tunnels: A tunnel is dark, making the engine crew less confident; a derailment in a tunnel is almost sure to result in serious damage and loss; the heat in long tunnels, especially if of small section, is intense; the track conditions, such as line and surface, are never as good as on the outside; the rail is generally damp, causing either the excessive use of sand, or the slipping of drivers; drainage in tunnels is usually bad, and difficult to improve; there are usually speed restrictions in tunnels. It was formerly the practice to carry maximum grades through tunnels in order to shorten them. This serious defect in many cases makes tunnels the ruling points. In tunnels of small section the use of helper engines is undesirable on account of the heat; the smoke and gas add to discomfort of operation; the impracticability of firing in long tunnels causes a drop in steam pressure.

There have been many plans devised for tunnel ventilation. Most of them are successful under some circumstances, but none is successful under all conditions. Long tunnels are generally built by means of shafts, and these shafts are sometimes left open to aid the ventilation. If the heat in the tunnel is greater than that outside, shafts will help when the atmosphere is low in humidity. When the humidity is high, shafts make but little difference in tunnel conditions. This is unfortunate, as tunnels at such times are very foul. Disc fans used in the shaft will operate satisfactorily sometimes, but their efficiency seems to vary about the same as the open shaft. Pure air blown down shafts is successful at times, but if the shaft is near the center it generally happens that

only one end of the tunnel is cleared out, the air remaining stationary at the other.

The Churchill system of ventilation, by which pure air is blown through the tunnel from one end through nozzles fitted at the sides of the tunnel, is successful, if the enginemen operate the locomotive so that the smoke is blown ahead of the engine. If two engines are used ahead on a train, and it is necessary to work the second engine, the position of the front engineer is unbearable. If one engine is used in the rear and one in front, and the smoke and gas from the second engine reaches the first one, the front engine crew are in the same position as in the case of the double-header, but if the train is skilfully handled, the smoke and gas of the rear engine will not reach the head engine. In tunnels where the grade inside is considerably less than the ruling grade, it is sometimes found possible to shut off one engine entirely, and in that case there is no difficulty, provided that the train does not move faster than the air current.

The natural tendency is to drive the engine as hard as possible through the tunnel on a heavy grade in order to get through quickly. The speed of the air currents in the Churchill system of ventilation in a tunnel a mile long usually averages about 8½ miles an hour over the whole distance. If the tunnel is being worked to anywhere near its capacity, the additional time in the tunnel may seriously limit the number of trains that may be put through it. It has been found, however, that if the tunnel is cleaned out by the ventilating apparatus before the passage of each train, there is little difficulty in getting through. As a rule, the engine crews prefer this method.

Double-track tunnels are of sufficient section so that there is little discomfort in a tunnel a mile long, even if the locomotive is fired all the way through. The practice in Europe has always been much better than that in the United States in that even with single-track tunnels their section has been large enough so that they are less uncomfortable than those in this country. Tunnel ventilation in Europe is largely restricted to the dilution of locomotive gas with plenty of fresh air, rather than driving the smoke and gas ahead of the engine.

In the construction of new tunnels, an effort should always be made to reduce the grade in the tunnel considerably below the ruling grade, so that there may be no need of touching the fire during the passage through the tunnel. Ample section to secure good conditions is essential. In this connection it should be noted that the effect of long single-track tunnels of narrow section on the ruling grade is to reduce the tonnage rating in the tunnel by 10 per cent at least.

Primarily it should be said that the effect of the length of a ruling grade depends entirely on what speed it is necessary to make up that grade. Hardly any operating division has more than 40 per cent of ruling grade in either direction. It is generally computed that a train must average ten miles an hour over a division of 100 miles in order to secure the best economy.

Assume a division with 40 miles of ruling grade, and 60 miles of either downhill or less than ruling grade. If eight miles per hour is averaged on the ruling grades, and 12 miles per hour on the down grades and less than ruling grades, the run may be made in ten hours. If a grade is very short, following a stretch of either downhill or less than ruling grade, sufficient speed may be had at the bottom to carry the train over the top, even though the ascending grade be considerably more than the ruling grade. As the train goes up the hill, its speed will constantly decrease. The speed at the top of the hill must be such that the engine still has some margin between its maximum tractive effort and what is required of it. This result depends entirely on the speed of the train at the foot of the grade. Such a grade is called a "momentum grade," and, while most railroad men will say it is not safe to depend on momentum, it is probable that there is not an important railroad in the country where the locomotive engineers cannot tell of portions of the line that are operated in that manner, even though the officers of the railroad do not know it. Were it not for momentum, it is likely that many curves would prove to be stalling points that are now passed around with little, if any, trouble. We are learning more every day about handling trains and power at low speeds, but it must be understood that these low speeds are only for use for short periods of time, and not for general practice over a whole run. When the grade is long enough for the train to become stretched out fully upon it, or, in other words, when the engine settles down to a constant speed with its maximum tonnage, the rating speed for that particular train becomes fixed. Without a rise in the steam pressure, the train cannot accelerate as long as the grade remains the same. If there is a large percentage of this character of line on the division, the rating speed must be considerably higher than if there are only one or two places. For instance, it may be possible to average seven miles per hour over one piece of grade, if that is the only piece on the division, because the difference in time should be made up on the rest of the division, but it would be manifestly improper to load an engine so that such a low speed would be made over the whole run. Not only the low speed, but the constant demand on the engine would be such that the fireman would play out, and a failure would be the result.

PROPER PERCENTAGE OF RATING.

It has been stated that a locomotive standing on a dry steel rail should be capable of exerting a pull on a spring balance equal to approximately ¼ its weight on drivers. This amount can be increased by the application of some medium to increase the co-efficient of friction, such as sand, to about 35 per cent. (for momentary purposes only). This same pulling power can be used to haul a train, including, of course, the engine and the tender itself.

Ratings in use are never as great as could be pulled by the locomotive utilizing a tractive power of ¼ the weight on drivers. The reason is apparent. Time is the essence of rating, just as it is the prime factor in all railroading. The governing question is: For how long a time must the locomotive be required to exert its maximum pull during any particular run? If it is required to exert a maximum effort for only about five minutes at a time, the rating might be established for a maximum effort, provided that time for rest of man and recuperation of fire elapses between the periods of maximum effort.

If maximum ratings were established for divisions where the ruling grades were long enough to require maximum effort for some time, the following conditions would have to be combated: Poor draft, owing to slow exhaust; poor fire on account of poor and intermittent draft; dirty fire on account of imperfect combustion; tired fireman on account of heavy work for a long time; steam failure, and stalling. It will be understood that, if an engine is adjusted to working under such conditions, an improvement may be had compared with an engine which is utilized on general service. The practical problem then is: How long can the ordinary fireman keep his fire in shape to deliver steam at full stroke? At what rate does his capacity deteriorate? At what rate can he maintain a steady and consistent performance for long periods of time?

In order to secure as uniform working conditions as possible, it is necessary to assign values as closely as possible to the rates mentioned. The accompanying plat will represent about what is considered fair practice. In order to apply the chart, find out how long a time it is feasible and practical for the locomotive to consume in ascending the ruling grade, and taking that time on the chart, follow up the line and see what percentage of full rating may be given the engine. It

is evident that when the percentage of rating gets as low as 60, it would pay to keep a full rating for the ruling grade with an assisting engine to avoid penalizing all the rest of the run improperly.

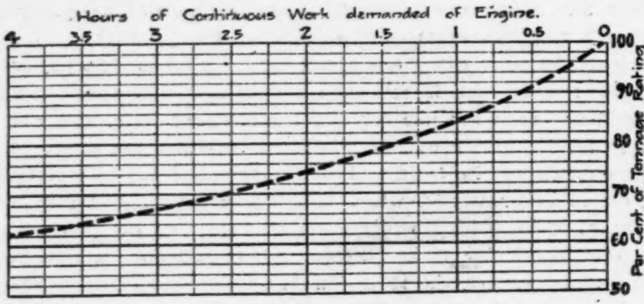


Diagram Showing Amount Rating Should Be Reduced on Account of Continued Work.

When the ruling factor in the operation is to conserve power, the greatest number of ton miles per engine mile is the figure to work for. This, however, will not always produce the lowest cost per ton mile. At times there is a shortage of train crews and a surplus of power. In this case it becomes imperative to make the greatest number of ton miles per train mile. This nearly always shows the greatest economy of movement.

Rate of Grade, Per Cent.	Adjustment	Ratio of Car Wgts., Per Cent.	Resistance of 20-ton Car	Resistance of 70-ton Car	Ratio of Resistance, Per Cent.
Level	54	60	166	276	60
0.1	29	50	206	416	50
0.2	20	44	246	556	44
0.3	15	41	286	696	41
0.4	12	39	326	836	39
0.5	10	37	366	976	37
0.6	8.5	36	406	1116	36
0.7	7.5	35	446	1256	35
0.8	6.7	35	486	1396	35
0.9	6.0	34	526	1536	34
1.0	5.4	34	566	1676	34
1.1	5.0	33	606	1816	33
1.2	4.6	33	646	1956	33
1.3	4.3	32	686	2096	32
1.4	4.0	32	726	2236	32
1.5	3.7	32	766	2376	32
1.6	3.5	32	806	2516	32
1.7	3.3	32	846	2656	32
1.8	3.1	32	886	2796	32
1.9	2.9	31	926	2936	31
2.0	2.8	31	966	3076	31
2.2	2.6	31	1046	3356	31
2.5	2.2	30	1166	3776	30
3.0	1.8	30	1366	4476	30

Ratios of Resistance and Car Weights Not Including Adjustments.

Rate of Grade, Per Cent.	Resistance of 20-ton Car, Pounds	Resistance of 70-ton Car, Pounds	Ratio of Resistance, Per Cent.	Ratio of Car Weights, Per Cent.
Level	166	276	60	20.5
.1	206	416	50	20.5
.2	246	556	44	20.5
.3	286	696	41	20.5
.4	326	836	39	20.5
.5	366	976	37	20.5
.6	406	1116	36	20.5
.7	446	1256	35	20.5
.8	486	1396	35	20.5
.9	526	1536	34	20.5
1.0	566	1676	34	20.5
1.1	606	1816	33	20.5
1.2	646	1956	33	20.5
1.3	686	2096	32	20.5
1.4	726	2236	32	20.5
1.5	766	2376	32	20.5
1.6	806	2516	32	20.5
1.7	846	2656	32	20.5
1.8	886	2796	32	20.5
1.9	926	2936	31	20.5
2.0	966	3076	31	20.5
2.2	1046	3356	31	20.5
2.5	1166	3776	30	20.5
3.0	1366	4476	30	20.5

Ratios of Resistance and Car Weights Including Adjustment.

An engine cannot do work and overcome train resistance unless it can transmit its cylinder work to the rail by means of adhesion due to the weight of the engine and the friction between wheel and rail. The adhesion of the wheels to the rails may be reduced by a number of circumstances as follows: Moisture acting as a lubricator, frost, grease, poor rail surface, manganese or other metals in the steel, excessive super-elevation, throwing too much weight on one side, and inability to use sand.

Assuming that, for rating purposes, the resistance formula, $R = 2.2\ T + 122\ C$, is correct, the resistance of a 20-ton car and a 70-ton car on different grades is shown in the accompanying table. Without a knowledge of train resistance under different conditions of car weight, it might be supposed that gross tonnage multiplied by the distance hauled would form the most accurate measure of work accomplished. The cost per gross ton mile would then be a measure of efficiency of operation. However, this is not true since it takes 60 per cent of the power to haul a 20-ton empty car on a level that it does to haul a 70-ton loaded car, while the empty car is less than 30 per cent of the weight of the loaded car. It, therefore, follows that as a measure of the cost of performed work the gross ton mileage alone is not an adequate basis of comparison. If, however, the adjustment figures are added to the weight of the car, the results become comparative at once, as shown in the second table.

ATTENDANCE AT THE COLISEUM.

There were more railway men at the Coliseum yesterday afternoon than at any previous time since the exhibition was opened last Saturday. The rules governing admission, by excluding those who were not directly interested in railways and have heretofore attended the show more as sightseers than anything else, resulted in confining the attendance practically altogether to railway officers and employees. The wisdom of this method of handling the attendance was demonstrated on several occasions when the crowds of railway men became so large that if they had been swelled by hundreds of mere sightseers there would not have been room enough for such a comfortable opportunity to inspect exhibits as the members of the Appliances Association have a right to expect and as railway officers enjoy. In a word, the exhibits have undoubtedly been more thoroughly inspected by railway men this year than ever before, principally because these men could take their time and were not crowded.

NEW SIGNAL INSTALLATIONS.

The Nashville & Gallatin Electric Railway (Tenn.) has installed a new signal system on its entire line, covering 25 miles of single track, which will be put in service before the end of this month. The Indianapolis & Cincinnati Traction Company has extended its signaling system to 45 miles of its lines in Indiana and Ohio. The new installation provides for complete switch protection and several new features of separate directional control of train movements are embodied in the dispatching apparatus. The Mesaba Railway Company has contracted for an installation of signals on 36 miles of line. Work will be commenced immediately. All of these installations will use the Simmen signal system.

RAILWAY BUSINESS ASSOCIATION DIRECTORS MEET.

The quarterly meeting of the directors of the Railway Business Association was held in Chicago yesterday. There were in attendance the president, George A. Post, president Standard Coupler Company; Col. H. G. Prout, vice-president and general manager Union Switch & Signal Co.; A. M.

Kittredge, president Kay & Ess Company; George W. Simmons, vice-president Simmons Hardware Company; F. T. Heffelfinger, president Peavey Grain Co.; Irving T. Hartz, president Morden Frog & Crossing Co.; J. C. Bradley, president Pratt & Letchworth Co.; James S. Stevenson, vice-president Berry Brothers, Ltd.; W. G. Pearce, vice-president American Brake Shoe & Foundry Co.; E. B. Leigh, president Chicago Railway Equipment Company; W. W. Salmon, president General Railway Signal Co. W. E. Clow, president James B. Clow & Sons; and F. W. Noxon, secretary of the Association.

The principal speeches made at the Association's last annual dinner in New York on December 19 were James J. Hill and W. L. McKenzie King, former Minister of Public Works of Canada. There has been such a demand for their addresses that the Association has sent out 56,000 copies of Mr. Hill's address and 55,000 of Mr. King's. The Association has also ascertained that these speeches were reported in newspapers and other publications having a total circulation of 9,000,000.

SIGNAL COMPANY SOLD.

The Federal Signal Company, Albany, N. Y., has completed negotiations for the purchase of the American Railway Signal Company of Cleveland, O.

ARRANGEMENTS COMMITTEE OF THE RAILWAY SIGNAL APPLIANCES ASSOCIATION.

The arrangements committee of the Railway Signal Appliance Association will hold a meeting at the Congress Hotel at 1 o'clock this afternoon, to make further arrangements for the annual convention to be held at Nashville, Tenn., next October.

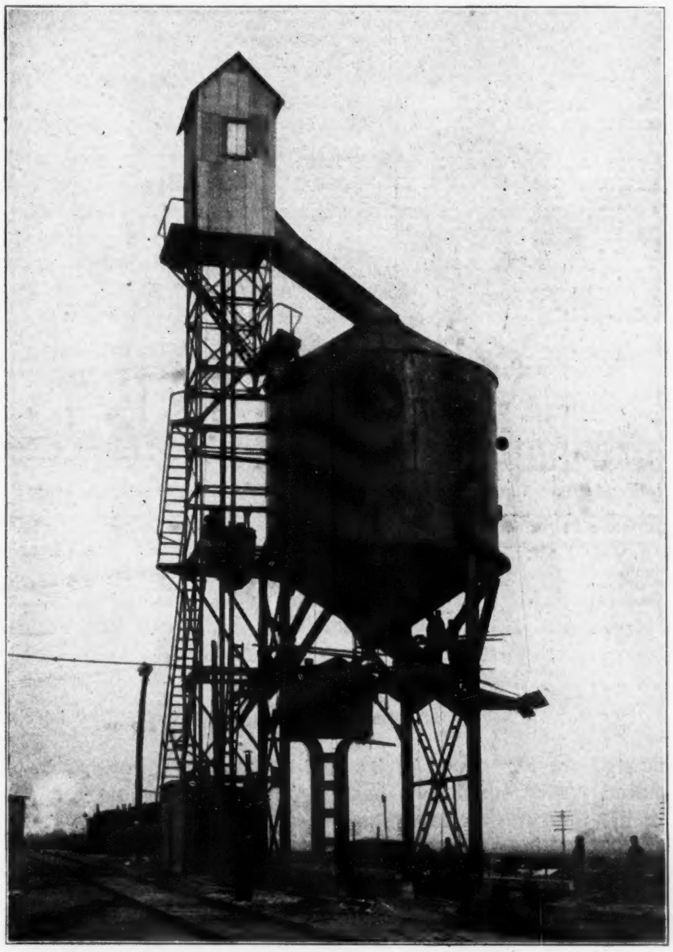
STEEL RAILS FOR CONCRETE REINFORCEMENT.

W. K. Hatt, professor of civil engineering, Purdue University, will deliver an illustrated lecture in the Florentine room, Congress Hotel, at 7:30 o'clock tonight in which he will present the results of tests on rolled steel rails for concrete reinforcing bars. As this lecture is to be informal and will be withheld from publication, the officers of the association are anxious to have a good representation of the members present to hear Dr. Hatt.

ALL-STEEL COALING STATION.

The accompanying cut illustrates an all-steel locomotive coaling station of 300 tons capacity arranged to coal on two tracks. While many of the mechanical devices for controlling and operating these stations are covered by patents, the type of bin with supports is made to suit the individual choice of the railway engineer in each case. The more common materials of construction—wood, concrete and steel—are all used, but wood is being abandoned in most of the newer structures where permanency is considered most important. In the all-steel structures the bottom is curved or conical, which causes all of the coal to move whenever the spouts are opened. This prevents spontaneous combustion. The roofs are also of conical steel. This form of bottom is not so easily made of wood or concrete as with steel because the curved and conical steel bottom is suspended and not supported except at its connection to the cylinder. It is probably the cheapest construction in many cases and is certainly more permanent than wood. It also occupies a minimum space, and has a very handsome appearance. The tank is tightly enclosed and objectionable dust or waste can be reduced to a minimum.

The structure here illustrated was built by the Des Moines Bridge and Iron Co., Pittsburgh, Pa., for Roberts & Shaefer,



All-Steel Coaling Station.

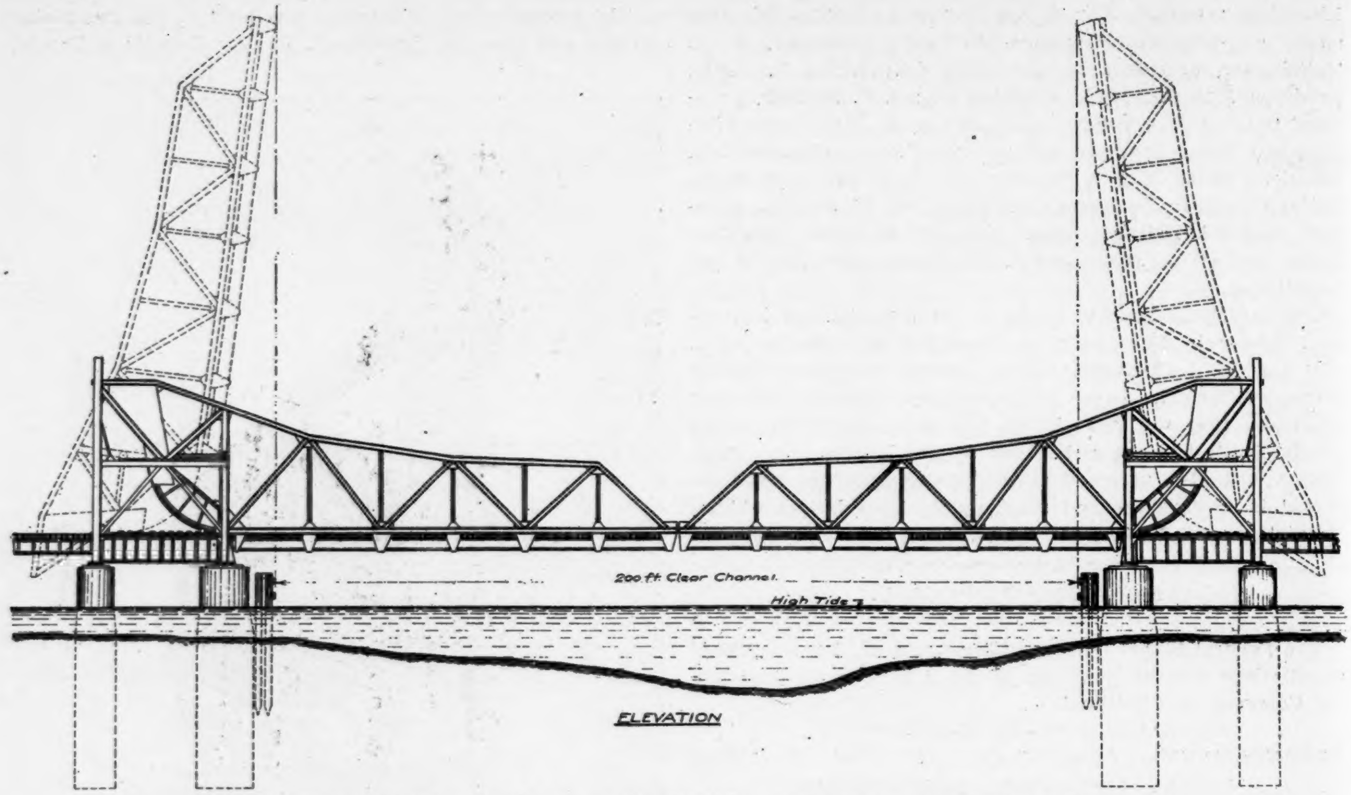
contracting engineers, Chicago. It is located on the Elgin, Joliet & Eastern at Rossville, Ill.

SCHERZER ROLLING LIFT BRIDGES.

The first Scherzer rolling lift bridge built for the Metropolitan West Side Elevated Railway across the Chicago river nearly 20 years ago has been and is now carrying continuously a traffic of more than 1,500 trains daily, which is thought to be a record for movable bridges. Although it is operated frequently to allow river vessels to pass, the maintenance charges have been small and the bridge is still in excellent condition. The structure consists of two double track bridges side by side.

The accompanying cut shows the double leaf cantilever Scherzer rolling lift bridge under construction across Pamban Channel, on the extension of the South Indian Railway lines from Southern India toward the Island of Ceylon. This structure will consist of a number of deck plate girder spans in combination with the through Scherzer rolling lift bridge across the navigable channel. The cantilever trusses of the movable span are similar to the double leaf bridge of this type constructed in 1908 for the Burma Railways across the Ngawun river, Burma.

The movable span of the South Indian Railway bridge is 225 ft., center to center of bearings, being 5 ft. longer than the Burma bridge. The clear channel for navigation is 200 ft. wide. When the bridge is open, it provides an unlimited vertical clearance, so as not to obstruct the highest



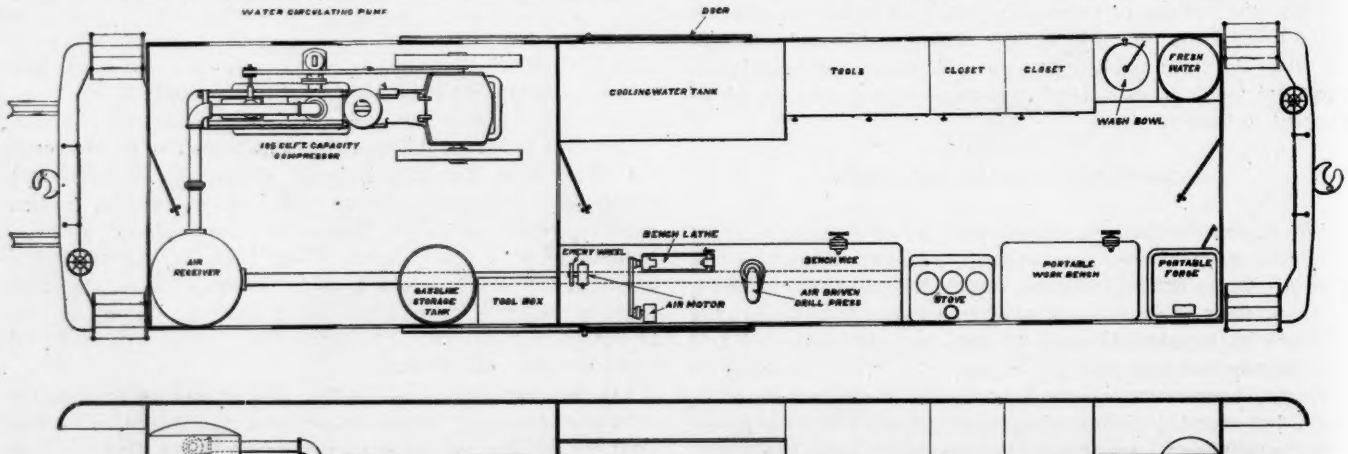
Scherzer Double Leaf Rolling Lift Bridge Across Pamban Channel, India.

masted vessels. Each bridge leaf is operated by one 25 h. p. motor. The foundations have been completed, and the approaches to the lift bridge are now nearing completion. This Scherzer bridge was fabricated in England, and erection will be completed within three or four months.

The Scherzer Rolling Lift Bridge Co., Chicago, prepared the designs, plans and specifications for the superstructure, operating machinery and power equipment and is acting in a consulting engineering capacity on the bridge, in cooperation with the engineers of the South Indian Railway.

RAILWAY REPAIR CAR.

The accompanying cut illustrates an installation of stationary and portable air tools operated by a gasoline engine driven compressor. The tools include drills, riveting and chipping hammers, painting machines and an air hoist. The arrangement of the car is such that it can be very conveniently used for bridge work either on new construction or repair work. The complete equipment for this car is furnished by the Chicago Pneumatic Tool Co., Chicago.



Chicago Pneumatic Tool Company's Railway Repair Car.